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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1201

Washington, D. C. ▼ March 19, 1924

# PLANTS TESTED FOR OR REPORTED TO POSSESS INSECTICIDAL PROPERTIES

By

N. E. McINDOO, Insect Physiologist, Fruit Insect Investigations, Bureau of Entomology, and A. F. SIEVERS, Chemical Biologist, Office of Drug, Poisonous, and Oil Plant Investigations, Bureau of Plant Industry

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By N. E. McIndoo, *Insect Physiologist, Fruit Insect Investigations, Bureau of Entomology*, and A. F. Sievers, *Chemical Biologist, Office of Drug, Poisonous, and Oil Plant Investigations, Bureau of Plant Industry.*

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## ECONOMIC ASPECTS OF PLANT INSECTICIDES.

The search for commercially valuable insecticides in the plant kingdom has two phases. The testing of the material to determine its effectiveness constitutes the first phase. After extensive laboratory and field tests have proved it to have sufficient merit, it then becomes necessary to determine the practicability of obtaining commercial quantities of the material and to make it available in proper form for insecticidal purposes. This constitutes the second phase.

Several factors must be considered in determining the practical availability of a plant insecticide. Among these may be mentioned (1) habitat, whether foreign or domestic, and whether wild or culti-

[1] The Bureaus of Entomology and Plant Industry in 1915 began a cooperative project which included a careful study of the physiological effects of the plant insecticides and a search for new insecticides in the plant kingdom. At the outset a search was begun for plants which would furnish materials for efficient insecticides. This bulletin embodies most of the unpublished results of this study and also includes as complete a catalogue as possible of all plants that have been tested for or reported to possess insecticidal properties. Some of the plant material used in this work has come from foreign countries, but the majority of the samples are from the United States and its possessions. Many persons, chiefly employees of the United States Department of Agriculture, who are widely scattered over the world, have sent much of this material. The scientific and common names, families, and habitats of the plants discussed have been verified by Drs. S. F. Blake, Frederick V. Coville, and W. E. Safford, all of the Bureau of Plant Industry.

vated; (2) characteristics of growth, whether annual or perennial, large or small, abundant or sparse; (3) portion of the plant effective; and (4) nature of the active constituent and the means necessary to make it available for use.

The most desirable type of plant is no doubt one which grows abundantly in a wild state, preferably in areas not readily adapted to the cultivation of valuable crops. Under such conditions the material could be obtained with the minimum of expense, the only cost being that of collection and preparation. Less abundant growth involves greater cost in collecting, and in case the plant must be cultivated it must bring sufficient return to compete with other crops adapted to that particular region. Perennials are much more desirable than annuals, since their products can usually be collected from year to year. Leaves and branches of trees or shrubs or the entire herbaceous portions of hardy perennials can be most economically obtained. On the other hand, the collecting of fruits or seeds or the digging of roots or rhizomes can, as a rule, be much less economically done. In the case of small plants, gathering the roots usually means the destruction of the plant, which, in time, is likely to reduce the supply unless the plant is under cultivation.

The character of the active constituent has an important bearing on the handling necessary in its preparation for the market. Substances like alkaloids and toxic resins are usually not subject to ready decomposition, and material containing such constituents need not be dried and handled with more than ordinary care. On the other hand, plant material depending for its action on glucosides must be carefully dried in order to inhibit decomposition of such constituents. In the case of plants native to foreign countries, especially the Tropics, this is an important matter, since the collecting is usually done by natives, and control of conditions of handling is likely to be difficult. Long voyages, especially by sea, are furthermore likely to cause deteriorating changes in such plant materials.

It is evident, therefore, that the search for a plant which may be made commercially available as an insecticide at a reasonable price extends much farther than merely finding a plant which possesses insecticidal properties to a satisfactory degree. It involves, in addition, a study of the botanical characteristics of such a plant, its habitat, the available natural supply, the means necessary for its proper collection and shipment, and, above all, the cost at which it can be delivered to the manufacturers in this country.

## METHODS USED BY THE WRITERS IN PREPARING PLANTS FOR INSECTICIDES.

To determine the insecticidal properties of plant material, a number of different ways of preparing it are necessary. This is especially true if the material is of unknown composition. Tests on insects may be made by applying the material (1) in a dry, finely ground condition as a dusting powder; (2) in the form of water extracts made with hot or cold water; or (3) as extracts made with other solvents, such as benzene, gasoline, petroleum ether, and alcohol. In all cases the material must be thoroughly dry, and then be reduced to a powder. If the powdered material is to be used as such

for dusting it should be very fine, at least fine enough to pass through a sieve having 60 meshes to the inch. If it is to be extracted such fineness is not always necessary. Cold-water extracts are best prepared by macerating the material in water for several days or longer, then filtering or straining, and making the aqueous extract up to the desired volume with more water. The cold-water method is necessary in the case of material which will decompose if heated. Decoctions, or hot-water extracts, are best made by boiling the ground material with water or percolating boiling water through it. These extracts may be concentrated, if necessary, to any desired volume by evaporating under reduced pressure (less than one atmosphere) on a steam bath. Plant material which can be used with satisfactory results as a powder or as a water extract may be sold in the powder form, with directions for use, because the preparation of the water extract, either hot or cold, is a simple process.

In many cases, however, the plant constituent which has the desired insecticidal effect can not be removed with water, but requires some organic solvent to effect its solution. In these cases the plant material is macerated or percolated with the desired solvent, either with or without heat, according to the nature of the active constituent. From the extracts obtained the solvents must be removed by distillation under reduced pressure. The concentrated extract must then be incorporated into a watery spray mixture. Since extracts made by means of alcohol, benzene, gasoline, or other organic solvents are usually insoluble in water, a special procedure is necessary to make a spray solution in which the organic extract is held in a fine and fairly stable suspension. The best method must usually be determined by trial for each individual case. In most cases the semisolid extract can be triturated with soft soap and water gradually incorporated so that a suspension of finely divided but undissolved particles results, giving the spray mixture a milky or muddy appearance. Frequent shaking will keep the mixture uniform in the sprayer.

## INSECTS EMPLOYED AND METHODS OF TESTING PREPARATIONS AGAINST THEM.

In all, 28 species of insects were tested—the squash lady-beetle (*Epilachna borealis* Fab.) and Colorado potato beetle (*Leptinotarsa decemlineata* Say) belonging to the Coleoptera; the house fly (*Musca domestica* L.) to the Diptera; the following 17 species of aphids to the Hemiptera: *Aphis* spp. called *A*, *B*, *C*, *D*, and *E*, cabbage aphis (*A. brassicae* L.), green apple aphis (*A. pomi* DeG.), nasturtium aphis (*A. rumicis* L.), *A. spiraecola* Patch, *Macrosiphum* spp. called *A*, *B*, and *C*, tulip-tree aphis (*M. liriodendri* Mon.), rose aphis (*M. rosae* L.), potato aphis (*M. solanifolii* Ashm.), chrysanthemum aphis (*Macrosiphonella sanborni* Gill.), and green peach aphis (*Myzus periscae* Sulz.); the honeybee (*Apis mellifica* L.) and sawfly larva (*Neurotoma fasciata* Norton) to the Hymenoptera; the silkworm (*Bombyx mori* L.), catalpa caterpillar (*Ceratomia catalpae* Bdv.), fall webworm (*Hyphantria cunea* Dru.), and tent caterpillar (*Malacosoma americana* Fab.) to the Lepidoptera; and the roach or croton bug (*Blattella germanica* L.) and grasshoppers (*Melanoplus femur-rubrum* DeG.) to the Orthoptera.

*Potato-beetle larvæ.*—Larvæ of the potato beetle were collected on potato plants and when brought to the laboratory were placed in cheesecloth cages, 9 inches square by 12 inches tall. The larvæ were so well mixed before they were placed in the cages that each cage contained about the same number in the various instars. Sprayed or dusted potato-plant foliage was given to them daily. Parasitism was common only among those in the last instar.

*House flies.*—Flies were reared in specially constructed screen-wire cages, 12 inches square by 18 inches tall, each of which contained one-half gallon of moist bran mash. The females readily oviposited in this mash, which later served as food for the larvæ and which proved a good substitute for manure. Large numbers of flies were thus reared, some of which were fed poisoned food in these cages, while others were transferred to small observation screen-wire cages in which they were dusted with powders.

*Aphids.*—Some of the aphids tested were sprayed or dusted outside the laboratory, but most of them were treated inside the laboratory in a manner similar to that described in another paper (*60, p. 508*).[2]

*Honeybees.*—Twenty young worker bees of practically the same age were placed in each of many screen-wire experimental cages and were fed in a manner similar to that described in another publication (*61, p. 181*). The sawfly larvæ were treated as described for aphids.

*Silkworms.*—Silkworm larvæ were reared in the laboratory and were fed leaves as follows: Mulberry-tree leaves were dusted or sprayed with the various preparations and with tap water (used as a control), an atomizer being used in all the spraying experiments. The leaves after having been dried in the air were cut into small strips which were then placed in small screen-wire cages. An effort was made to put approximately the same amount of food in each cage, so that a rough comparative estimate of the food consumed could be made; this procedure was also followed while feeding the other species of chewing insects. Ten normal silkworms, all of practically the same size and not ready to molt, were put in each cage. Counts were made daily (except on Sundays), the cages being cleaned and treated food being renewed at the same time. No disease was noticed among these larvæ.

*Fall webworms.*—Webs of the fall webworm were collected in the fields on Monday from a variety of plants; after being brought to the laboratory, these webs containing the webworms were kept in large cages with a small amount of food till Tuesday noon, by which time the larvæ were well mixed according to size (all instars but the first one), and by this time they were very hungry. Tuesday morning approximately the same amount of mulberry-tree foliage was placed in each of several wide-mouthed bottles containing water; it was then sprayed or dusted, and when the foliage was dry each bottle with contents was placed in a large battery jar, 8 inches in diameter by 12 inches tall. Tuesday afternoon an effort was made to place approximately the same number of webworms in each jar,

[2] The figures (*italic*) in parentheses refer to "Literature cited," p. 54.

and dusted or sprayed food thereafter was renewed daily. Thus by starting each set of experiments on the same day of the week, the days (Sundays) on which no records were taken always fell on the fifth, twelfth, and nineteenth days of the tests. Very little disease was noticed, and parasitism was not bad among these larvæ.

*Tent caterpillars.*—Tent-caterpillar tents were collected in the fields from wild-cherry trees, and were later handled as already described for the webs of webworms. Dusted or sprayed wild-cherry-tree foliage was placed in the jars daily and counts were made daily as usual. Owing to the prevalence of the "wilt" or polyhedral disease, it was necessary to test these larvæ while they were in the earliest instars, because during the last instar they were badly diseased.

*Catalpa caterpillars.*—Catalpa caterpillars were collected on catalpa trees, and when transferred to the laboratory were treated as described for the webworms and tent caterpillars.

*Roaches.*—These insects were reared in a specially constructed roach box which was very suitable for the purpose. On various dates 20 or 25 were put in each of several small screen-wire cages in which they were dusted or fed poisoned foods.

*Grasshoppers.*—Grasshoppers in the fourth, fifth, and sixth (adult) instars, caught in the fields, were either fed poisoned bran mash in the cheesecloth cages, already described, or were dusted in the small screen-wire cages.

*Fumigating tests.*—The insects to be tested were put in the large battery jars, 8 inches (20.32 centimeters) in diameter by 12 inches (30.48 centimeters) tall, each with a capacity of about 9.8 liters; then a 1-gram cone of powder was placed in each jar; next the powder was ignited; and finally a glass cover, almost airtight, was placed over each jar.

## RESULTS OBTAINED BY THE WRITERS.

The writers have tested 232 preparations from 54 species of plants (not including tests of which the results have already been published) against a total number of 28 species of insects. Some of the more important results obtained are recorded in Tables 1 to 8. The plants first discussed are arranged alphabetically by genera, but under the subheading "Comparative results discussed" this arrangement is not maintained, although it is for the remainder of the discussion under the heading "Discussion of the less important results obtained."

For a more complete account of the species of plants discussed, the reader is referred to the "Catalogue of plants tested for or reported to possess insecticidal properties" and to the "Index of botanical and common names of plants catalogued."

### DISCUSSION OF THE MORE IMPORTANT RESULTS OBTAINED.

#### AMIANTHIUM OR CROW POISON.

The writers obtained the following results by using amianthium or crow poison (*Chrosperma muscaetoxicum*). The powdered bulbs

and leaves (Nos. 33*a*, *b*, and *f*, each used as a dust) were efficient but slow against roaches, grasshoppers, flies, and bees (Table 1), but inefficient against *Aphis* spp. *A* and *B* (Table 2), and had little effect on tent caterpillars. Used as a stomach poison, these powders were efficient against grasshoppers, silkworms, and flies (Table 1), but had no effect on large webworms.

The water extracts (highly concentrated) from the leaves and bulbs of amianthium, each sprayed upon the insects and their food, had considerable effect on roaches, potato-beetle larvæ, and silkworms, but none on webworms, potato aphids, rose aphids, and *Aphis* spp. *A* and *B* (No. 35fa, Table 3). The alcoholic and benzene extracts (Nos. 504 and 513, Table 4) from the bulbs, used with soap, were inefficient against four species of aphids (*Aphis* spp. *A* and *B*, *Macrosiphum* spp. *A*, and *M. liriodendri*). The alcoholic extract, however, was efficient against silkworms.

At Vienna, Va., three apple trees, each bearing a nest of tent caterpillars from one-half to three-fourths grown, were selected for preliminary field tests. One tree was sprayed with a 10 per cent solution of a water extract from the leaves of amianthium; another tree with a 10 per cent solution of a water extract from the bulbs; and the third tree served as a control. A week later the caterpillars on the sprayed trees appeared shrunken and apparently had not eaten since the trees had been sprayed. The caterpillars on the control tree and others near by were almost full grown.

#### INSECT POWDER OR PYRETHRUM.

The following results were obtained by using a commercial insect powder, here called pyrethrum, and probably derived from *Chrysanthemum cinerariaefolium*. Most of the details will be given when comparing these results with those obtained by using certain other plants (see pp. 10 to 21). The powders (Nos. 103 and 503, Table 2), used as dusts, were found efficient against five species of aphids (*Aphis* spp. *A* and *B*, *Macrosiphum* spp. *A* and *B*, and *Macrosiphonella sanborni*), grasshoppers, silkworms, flies, potato-beetle larvæ (Table 1), and tent caterpillars; used as a decoction, not filtered (No. 103a, Table 3), it was efficient against *Aphis* spp. *A* and *B*, but used as a hot-water extract (filtered, No. 103b), it had no effect on these insects; used as a fumigant (No. 103), it was efficient against *Macrosiphum* sp. *C* and *Myzus persicae*, silkworms, webworms, and a lady-beetle tested. The hot-water extract (filtered) and a distillate were efficient against silkworms, but the cold-water extract (filtered) was inefficient.

The alcoholic and benzene extracts, when sufficiently strong and used with soap or kerosene emulsion, were found efficient against aphids (Tables 4, 5, and 6). The alcoholic extract, used with soap, was efficient against small webworms (first instar) and half-grown sawfly larvæ, but only about 50 per cent of the larvæ and none of the adult potato beetles tested were killed within seven days.

#### "CUBE."

In 1920, while collecting fishes in Peru for Indiana University, Dr. W. R. Allen procured a supply of the dried roots of "cube" (see footnote on p. 34); some of these were used as a fish poison and

the others were brought home. The latter were afterwards ground and some of the powder was sent to the writers by Dr. C. H. Eigenmann, who was in charge of the expedition to Peru and Ecuador.

According to a letter from Doctor Allen, "cube" or "barbasco" is a woody shrub whose roots contain a milky sap of a very poisonous character. In Peru the sap is used as a wash for cattle to kill ticks and the roots are unlawfully employed to poison fish in streams. (See pp. 10 to 20.)

The following results were obtained by using "cube." The powder (No. 501), used as a dust, was efficient against potato-beetle larvæ (Table 1) and four species of aphids (*Aphis* spp. *A* and *B*, *A. rumicis*, and *Macrosiphum solanifolii*, Table 2), but inefficient against *Macrosiphum* sp. *A;* used as a fumigant, it was efficient against *Macrosiphum* sp. *C* (Table 3) and the one species of lady-beetle tested; used as an infusion (No. 501c), it was efficient against *Aphis rumicis* and *Macrosiphum solanifolii;* used as a decoction (No. 501a), it was efficient but slow against *Aphis* spp. *A* and *B;* and used as a hot-water extract (No. 501b), it was efficient against the same species. Used as a cold-water extract (No. 528, Table 7) with soap, it had practically no effect on *Macrosiphum solanifolii*, *M.* sp. *C*, and *Aphis* sp. *E*.

The cold alcoholic extract (No. 506) of "cube," used without soap, was efficient against silkworms and *Macrosiphum* sp. *A* (Table 5); used with soap it was efficient against *Aphis* spp. *A*, *B*, and *E* (Tables 4, 6, and 7), *Macrosiphum* sp. *A* (Tables 5 to 7), *M. rosae*, *M. solanifolii*, *M.* sp. *C*, *Aphis spiraecola* (Table 6), *M. liriodendri*, and against potato-beetle larvæ and sawfly larvæ, but inefficient against webworms and the adults of potato beetles; and used with kerosene emulsion, it was efficient against *Macrosiphum solanifolii*, *M.* sp. *C*, and *Aphis* spp. *C*, *D*, and *E* (Table 6). The hot-water extract (No. 525), used with soap, was efficient against *Macrosiphum* sp. *A*, but inefficient against *Aphis* sp. *E* (Table 7). The benzene extract, used with soap, was efficient against *Macrosiphum* sp. *A* (Table 5), and *M. rosae*. The dry resin (No. 526) from the powder, dissolved in alcohol and used with soap, was inefficient against *Macrosiphum solanifolii*, *M.* sp. *C*, *Aphis spiraecola*, and *A.* sp. *E* (Table 7). The filtrate (No. 527), obtained from a cold alcoholic extract which had been concentrated, precipitated in water, and filtered, was practically ineffective against *Macrosiphum solanifolii*, *M.* sp. *C*, and *Aphis* sp. *E* (Table 7).

The powder of "cube," dusted into the hair of three cats badly infested with Mallophaga, was efficient, but the cats became sick from licking themselves.

### DERRIS.

Following are the summarized results, obtained by using a commercial powder, consisting of a mixture of *Derris elliptica* and *D. uliginosa*. The powder, used as a dust (No. 110, Table 2), was efficient against three species of aphids (*Aphis* sp. *A* and *B*, and *Macrosiphonella sanborni*), and silkworms (Table 1), but killed only about half of the *Macrosiphum* sp. *A* tested within 24 hours; used as a decoction (No. 110a, not filtered) and also as a hot-water extract (No. 110b, filtered), it was efficient against *Aphis* sp. *A* and *B* (Table 3), and used as a fumigant (No. 110) it was efficient

against *Myzus persicae*, *Macrosiphum* sp. *C*, silkworms, and the lady-beetle tested, but inefficient against webworms and small tent caterpillars.

The alcoholic and benzene extracts of derris, when sufficiently strong and used with soap or kerosene emulsion, were found efficient against many species of aphids (Tables 4 to 6). The alcoholic extract, used with soap, was efficient against half-grown sawfly larvæ, but inefficient against small webworms (first instar) and the larvæ and adults of potato beetles.

At Tallulah, La., a commercial preparation of powdered derris was used on three dogs which were infested with fleas (*Ctenocephalus canis* Curt.). It was found efficient against the fleas.

#### SANDBOXTREE.

None of the six preparations of the sandboxtree (*Hura crepitans*) sprayed on aphids proved efficient (Table 8). A 10 per cent and a 20 per cent sap killed most of the aphids tested within three days, but this reaction time is entirely too slow for practical purposes, and even the sap 5 per cent and 10 per cent mixed with soap was inefficient. The alcoholic extracts of the bark and sawdust were inefficient, but the extract of the bark seems promising, and probably a stronger mixture would have been efficient.

#### TOMATO VINES.

Powders from tomato vines (*Lycopersicum esculentum*), applied as dusts, were ineffective on webworms, silkworms, potato-beetle larvæ, rose aphids, and tent caterpillars, but they had a considerable effect on roaches; mixed with food, they had a slight effect on grasshoppers and roaches and seemed efficient against flies (No. 11, Table 1). Used as a fumigant, the powder was practically ineffective against *Myzus persicae*.

The water extracts from tomato vines had practically no effect on bees and tent caterpillars, but affected grasshoppers and flies considerably. The alcoholic and ether extracts were very effective on flies and bees.

#### CHINABERRY.

The hot-water extract of the berries of the chinaberry (*Melia azedarach*) and also of the undried berries was efficient against bees and had a slight effect on roaches. The powdered leaves and water extracts (not filtered) from this powder were efficient against silkworms, but had only a slight effect on *Aphis* spp. *A* and *B* (Nos. 23k and 301a, Tables 2 and 3), and on tent caterpillars.

The alcoholic, ether, and petroleum-ether extracts of chinaberry were fatal to bees; but a strong alcoholic extract did not kill any of the silkworms tested. The alcoholic and benzene extracts (Nos. 505 and 514, Table 4), used with soap were inefficient against *Aphis* spp. *A* and *B*, *Macrosiphum* sp. *A*, and *M. liriodendri*.

#### TOBACCO.

The results obtained by using common tobacco (*Nicotiana tabacum*) in the form of nicotine resinate and sulphate are as follows: About 90 per cent of the chrysanthemum aphids and 98 per cent of the nas-

turtium aphids sprayed with nicotine resinate were killed, while the same mixture applied to apple trees was efficient against *Aphis pomi*. The results obtained with nicotine sulphate are given in Tables 4 to 6.

### CASTOR-BEAN.

The juice from the leaves and green pods of a castor-bean plant (*Ricinus communis*) had only a slight effect on bees. The powdered beans and husks, free of oil, killed all the bees tested; but some of this powder, after having been extracted with a 10 per cent solution of sodium chlorid, apparently did not kill any of the bees tested. Several attempts at feeding dough mixed with the powdered beans to roaches failed. The powder had no effect on webworms, but had a slight effect on silkworms, flies, and grasshoppers.

An alcoholic extract of castor-beans, when reasonably strong and used with soap (No. 511, Table 4), was inefficient against three species of aphids (*Aphis* spp. *A* and *B*, and *Macrosiphum* sp. *A*), but when fed to silkworms without the addition of soap it had no effect on these larvæ. A benzene extract (No. 520), when exceedingly strong and used with soap, was efficient against *Macrosiphum* sp. *A*, but the control mixture seemed to have killed half the number.

### SABADILLA.

Using sabadilla seed (*Schoenocaulon officinale*), the following results were obtained: The powders (Nos. 56 and 121, *oil extracted*), used as dusts, were efficient against grasshoppers, roaches, bees (Table 1), silkworms, and webworms, but they had practically no effect on five species of aphids (*Aphis rumicis*, *A. brassicae*, *A.* spp. *A* and *B*, and *Macrosiphonella sanborni*): the powder (No. 113, *oil not extracted*), used also as a dust, was efficient against silkworms (Table 1), but had practically no effect on the third, fourth (Table 2), and fifth species of the above aphids.

The powders (Nos. 56 and 113) of sabadilla seed, used as fumigants, had only a slight effect on silkworms and webworms, but were efficient against *Macrosiphum* sp. *C* and *Myzus persicae* (Table 3) and against the one lady-beetle tested.

The powder (No. 56a) of sabadilla seed, used as a decoction, had no effect on *Aphis* spp. *A* and *B* (Table 3). A soda extract, used as a spray material, had no effect on nasturtium and cabbage aphids, but was efficient against grasshoppers, bees, and small webworms. Hot and cold water extracts, used as spray materials, had no effect on nasturtium and cabbage aphids, but were efficient against grasshoppers, bees, and silkworms. An oil, extracted by petroleum ether and used as a spray material, suspended in water, was efficient against grasshoppers. Oxalic acid extracts were efficient against silkworms, while oxalic acid, used as a control, had no effect on them. A distillate also had no effect on silkworms. The alcoholic and benzene extracts (Nos. 510 and 519), used with soap (Table 4), were inefficient against three species of aphids (*Aphis* spp. *A* and *B* and *Macrosiphum* sp. *A*). The alcoholic extract was efficient but very slow against silkworms.

### HELLEBORE.

The commercial powder of white false-hellebore (*Veratrum album*), used as a dust, was efficient but slow against roaches and silkworms

and had a slight effect on bees (No. 109, Table 1) and tent caterpillars, and on *Aphis* spp. *A* and *B* (No. 502, Table 2); used as a decoction (No. 502a, not filtered), it had no effect on the same species of aphids (Table 3); used as a fumigant (No. 502), it killed only 75 per cent of the *Macrosiphum* sp. *C* tested, besides the one ladybeetle and one of the five large webworms tested; and used as a stomach poison, it was efficient but slow against grasshoppers and silkworms (No. 109, Table 1).

The hot and cold water extracts, alcoholic extract, and distillate from white hellebore were efficient but slow against silkworms, although a 0.5 per cent solution of veratrine in weak sulphuric acid killed the silkworms more quickly. The alcoholic and benzene extracts, used with soap (Nos. 508 and 517, Table 4), were inefficient against four species of aphids (*Aphis* spp. *A* and *B*, *Macrosiphum* sp. *A*, and *M. liriodendri*).

The powdered roots of white hellebore and the hot-water extract of these (not commercial) were found efficient but very slow against silkworms, although they had no effect on rose aphids.

### COMPARATIVE RESULTS DISCUSSED.

*Powders dusted upon or fed to six species of insects.*—Reference to Table 1 shows the following: Of the five powders dusted upon roaches, sabadilla and pyrethrum kill quickly and seem almost equally efficient; derris has no practical value; and since hellebore and amianthium, although efficient, kill so slowly, they can not be recommended as satisfactory roach poisons.

Relative to the four powders fed to and dusted upon grasshoppers, all were efficient, but only pyrethrum killed quickly, and for practical purposes none of these can replace the arsenicals as grasshopper poisons.

Of the five powders fed to and dusted upon silkworms, only derris, amianthium, and pyrethrum killed quickly, although hellebore and sabadilla were efficient but slow.

Relative to the four powders used against flies, pyrethrum seems to be the best dust, but derris is a close second. Used as a stomach poison, amianthium killed all the flies tested within four or five days; and amianthium used as a dust killed all of them within four days.

Of the three powders dusted upon honeybees, sabadilla and amianthium killed them comparatively quickly, while hellebore acted slowly.

Of the three powders dusted upon potato-beetle larvæ in a potato patch, pyrethrum acted the most quickly, although all the larvæ dusted with derris, "cube," and pyrethrum were dead within 24 hours.

*Powders dusted upon aphids.*—Reference to Table 2 shows the following: Used as dusts, sabadilla, amianthium, and hellebore had no practical value against two species of aphids (*Aphis* sp. *A* omitted for these powders). Pyrethrum was efficient against all five species of aphids tested; while "cube" was efficient against four out of five species, and derris against three out of four species tested.

*Powders used as fumigants, decoctions, infusions, and hot-water extracts.*—Reference to Table 3 shows the following: Used as fumi-

gants against two species of aphids, sabadilla, pyrethrum, derris, and "cube" were efficient, while hellebore was inefficient.

Used as decoctions against *Aphis* spp. *A* and *B*, sabadilla, amianthium, and hellebore had practically no effect (*Aphis* sp. *A* omitted for these three powders): but pyrethrum, derris, and "cube" were efficient. Used as hot-water extracts (decoctions filtered) against the same species, pyrethrum had no effect; derris killed 60 per cent within 24 hours, while "cube" killed practically all within the same time.

Used as an infusion against two other species of aphids, "cube" was quickly efficient.

*Alcoholic and benzene extracts of various powders.*—Reference to Table 4 shows the following:[3] The alcoholic extracts+soap+water (2+4+100) of sabadilla, amianthium, and hellebore were inefficient against *Aphis* spp. *A* and *B*, while those of pyrethrum, derris, and "cube" were efficient. The alcoholic extracts (8+2+100) of the first three powders were also inefficient against *Macrosiphum* sp. *A*, while the benzene extracts (8+2+100) of the same powders seemed efficient, although the control mixture evidently killed 50 per cent of them. The nicotine sulphate (1/1,200)+soap+water (0.8+2+100) was efficient, although it killed rather slowly.

*Alcoholic and benzene extracts and nicotine sulphate against Macrosiphum sp. A.*—Reference to Table 5 shows the following comparative results obtained by spraying *Macrosiphum* sp. *A*: The alcoholic extracts+water (4+100) of "cube," derris, and pyrethrum were efficient within three days; "cube" is best and derris is slightly better than pyrethrum.

The alcoholic extracts+soap+water (4+2+100) of "cube," derris, and pyrethrum and nicotine sulphate (1/400)+soap+water (2.5+2+100) are about equally toxic; the same extracts (2+2+100) and nicotine sulphate (2.5+2+100) are about equally toxic, but the extract of pyrethrum acts the most slowly; the alcoholic and benzene extracts (1+2+100) of "cube" and derris and nicotine sulphate (2.5+2+100) are equally efficient, but the alcoholic and benzene extracts (1+2+100) of pyrethrum are inefficient: the alcoholic extract (3/4+2+100) and the alcoholic and benzene extracts (1/2+2+100) of "cube," and nicotine sulphate (2.5+2+100) are about equally toxic, while those of derris are less toxic and may be compared with nicotine sulphate (1/800) or (1.25+2+100), and those of pyrethrum are far below efficiency: the alcoholic and benzene extracts (1/3, 1/4, 1/5, and 1/6+2+100) of "cube" and nicotine sulphate (1.25+2+100) compare favorably in toxicity, while those (1/3 and 1/4+2+100) of derris are inefficient.

*Alcoholic extracts and nicotine sulphate against 11 species of aphids.*—Reference to Table 6 shows the comparative results obtained by spraying 11 species of aphids with alcoholic extracts. In

[3] In Tables 4 to 8 the expression "alcoholic extract + soap + water (2 + 4 + 100)" means that the extract from 2 pounds of powder was mixed with 4 pounds of fish-oil soap and 100 gallons of water. The expression "Control, alcohol + soap + water (2 + 4 + 100)" means the same amount of alcohol, soap, and water as used in the preceding mixture; or, in other words, this mixture differs from the preceding only in that it does not contain the dry extract. The expression "40 per cent nicotine sulphate (1/1,200) + soap + water (0.8 + 2 + 100)" means 1 part by volume or 0.8 pound of nicotine sulphate to 1,200 parts of soap solution (2 pounds to 100 gallons of water). The weight of the nicotine sulphate is merely given so that its cost can be compared with that of the various powders used.

this table the results obtained by spraying the extracts of "cube," derris, and pyrethrum, and the nicotine sulphate upon *Macrosiphum* sp. *A* are the same as recorded in Table 5.

The extracts+soap+water (2, 1, and 1/2+2+100) of "cube," those of derris (2 and 1+2+100), and nicotine sulphate (1/400)+soap+water (2.5+2+100) are equally toxic against *Macrosiphum rosae* (none over half grown); while pyrethrum extract (2+2+100), derris extract (1/2+2+100), and nicotine sulphate (1/800) are about equally toxic, but the pyrethrum extracts (1 and 1/2+2+100) were less toxic and were inefficient.

The potato aphis (*M. solanifolii*), living on the pubescent underside of the leaves of a western jimson weed (*Datura meteloides* Dunal), were particularly difficult to kill. Nicotine sulphate (1/400) with soap (2+100) killed only 75 per cent of them within 24 hours, and nicotine sulphate (1/800) only 60 per cent; but when the soap was doubled, 95 per cent of the aphids were killed by each of the nicotine sulphate solutions. The extracts+soap+water (4+4+100) of "cube," derris, and pyrethrum were found efficient against this aphis, but a "cube" extract (2+2+100) killed only 50 per cent of them within 24 hours. The most satisfactory mixtures tested on this aphis were kerosene emulsions containing the extracts. The extracts+water (1+100) of "cube," derris, and pyrethrum+2.5 per cent of kerosene emulsion were about equally toxic and efficient; while the pyrethrum extract (2+100), derris extract (1+100), and "cube" extracts (1 and 1/2+100), each +1.25 per cent kerosene emulsion, were efficient; but the pyrethrum extract (1 and 1/2+100), and derris extract (1/2+100), each +1.25 per cent of kerosene emulsion, were inefficient. The extracts + soap + water (1+4+100) killed about 20 per cent of the aphids, while the control mixture containing 2.5 per cent of kerosene emulsion killed only 15 per cent of the aphids sprayed. This shows the effect of adding the extracts to the kerosene emulsion.

Table 6 shows that these alcoholic extracts are very promising insecticides, although not all of the 11 species of aphids tested were easily killed by them. Regarding the minimum dosage required to produce efficient killing, which is here considered 90 per cent or more within 24 hours, it appears that "cube" extract is 12 times as toxic as pyrethrum extract and 3 times as toxic as derris extract. These differences in toxicity are partially explained by the fact that the concentration of the "cube" extract is 5.29 per cent, while the concentrations of the derris and pyrethrum extracts, respectively, are 2.89 per cent and 4.08 per cent. Relative to the following four insecticides used with soap (2 pounds to 100 gallons of water), the lowest concentrations found which produce efficient killing are: Pyrethrum extract from 2 pounds of powder, derris extract from one-half pound, "cube" extract from one-sixth pound, and 40 per cent nicotine sulphate (1/1,200 strength).

*Various extracts from "cube" against aphids.*—Reference to Table 7 shows the comparative results obtained by spraying five species of aphids with various "cube" extracts. Practically no difference in toxicity between the cold and hot alcoholic extracts is shown. The resin was inefficient in all tests, and consequently contains only a portion of the toxic principle present in this plant, but in the

studies on derris (*61*) the resin was found to be the toxic principle. The filtrate and cold-water extract were practically ineffective. (See p. 7.)

*Extracts of "cube," derris, and pyrethrum, and nicotine sulphate used in field experiments.*—Four rows of potatoes, badly infested with potato beetles, and one large rose bush, badly infested with rose aphids, were sprayed with a commercial extract of derris (1/400) in soap solution (4/100). Another four rows of potatoes and another rose bush, similarly infested, were sprayed with a commercial soapy extract of pyrethrum (1/400) in soap solution (4/100), fish-oil soap being used in all these tests. Both preparations were found efficient against the potato-beetle larvæ, but had practically no effect on the adult potato beetles and were inefficient against the rose aphids.

In July and August, 1922, the following experiments were performed on aphids at Tallulah, La., by mixing various dilutions of the insecticides with soap solution (4/100), laundry soap being used. Small portions of rows of cotton plants, each 100 feet long and badly infested with the cotton aphis (*Aphis gossypii* Glover), were sprayed with alcoholic extracts of "cube," derris, and pyrethrum (prepared in the laboratory), with commercial extracts of derris and pyrethrum, and with 40 per cent nicotine sulphate.

Using the laboratory products, the following percentages of aphids were killed:

| | Per cent. |
|---|---|
| "Cube:" | |
| 1/2+4+100 | 99 |
| 1/3+4+100 | 98 |
| 1/4+4+100 | 95 |
| Derris: | |
| 1/3+4+100 | 95 |
| Pyrethrum: | |
| 1+4+100 | 90 |

Using the commercial products, the following percentages of aphids were killed:

| | Per cent. |
|---|---|
| Derris: | |
| 1/2,000 | 95 |
| 1/1,600 | 99 |
| 1/1,000 | 99 |
| 40 per cent nicotine sulphate: | |
| 1/1,600 | 95 |
| 1/1,200 | 96 |
| 1/800 | 99 |
| Pyrethrum: | |
| 1/1,000 | 95 |

The following percentages were obtained by spraying many large weeds heavily infested with large red aphids (*Macrosiphum ambrosiae* Thos.), with some of the preceding products:

| | Per cent. |
|---|---|
| Derris: | |
| 1/1,600 | 100 |
| 40 per cent nicotine sulphate: | |
| 1/1,200 | 100 |
| Pyrethrum: | |
| 1/1,000 | 95 |
| "Cube:" | |
| 1/3+4+100 | 100 |

TABLE 1.—*Comparative results obtained by testing various powders against six species of insects in the form of dusts and stomach poisons.*

| Sample No. | Species and preparation. | Number of insects and how tested. | | | Percentage of insects dead within—[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of individuals. | Number of sets. | How tested. | 6 hours. | 1 day. | 2 days. | 3 days. | 4 days. | 5 days. | 6 days. | 7 days. |
| | Roaches: | | | | | | | | | | | |
| 33a | Amianthium[2] | 120 | 6 | Dusted. | 0 | 5 | 50 | 61 | 89 | 97 | 99 | 100 |
| 33b | Do[3] | 120 | 6 | ...do... | 1 | 8 | 13 | 79 | 90 | 98 | 99 | 100 |
| 109 | Hellebore | 120 | 6 | ...do... | 0 | 7 | 13 | 36 | 54 | 78 | 84 | 91 |
| 110 | Derris | 25 | 1 | ...do... | 8 | 44 | 76 | 88 | 88 | 88 | 88 | 88 |
| 56 | Sabadilla[4] | 25 | 1 | ...do... | 24 | 32 | 84 | 100 | ..... | ..... | ..... | ..... |
| 103 | Pyrethrum | 25 | 1 | ...do... | 20 | 72 | 100 | ..... | ..... | ..... | ..... | ..... |
| 501 | "Cube" | 25 | 1 | ...do... | 4 | 76 | 92 | 96 | 96 | 96 | 96 | 96 |
| | Control | 120 | 6 | ..... | 0 | 4 | 5 | 7 | 9 | 12 | 21 | 35 |
| | Grasshoppers: | | | | | | | | | | | |
| 33a | Amianthium | 30 | 2 | Fed.... | 0 | 7 | 13 | 23 | 57 | 90 | 100 | ..... |
| 33b | Do | 20 | 2 | ...do... | 0 | 10 | 30 | 50 | 80 | 85 | 100 | ..... |
| 35f | Do[5] | 33 | 2 | Dusted. | 3 | 27 | 54 | 100 | ..... | ..... | ..... | ..... |
| 109 | Hellebore | 10 | 1 | Fed.... | 0 | 10 | 20 | 30 | 50 | 90 | 100 | ..... |
| 56 | Sabadilla | 36 | 3 | Dusted. | 28 | 75 | 92 | 97 | 100 | ..... | ..... | ..... |
| 103 | Pyrethrum | 10 | 1 | ...do... | 10 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control | 20 | 2 | ..... | 0 | 0 | 0 | 0 | 0 | 30 | 55 | ..... |
| | Silkworms: | | | | | | | | | | | |
| 121 | Sabadilla[5] | 70 | 7 | Dusted. | 11 | 24 | 57 | 76 | 87 | 93 | 97 | 100 |
| 113 | Do[6] | 90 | 9 | ...do... | 24 | 57 | 63 | 97 | 99 | 100 | ..... | ..... |
| 109 | Hellebore | 40 | 4 | ...do... | 5 | 28 | 48 | 65 | 75 | 86 | 93 | 100 |
| 109 | Do | 20 | 2 | Fed.... | 0 | 15 | 40 | 85 | 85 | 95 | 100 | ..... |
| 103 | Pyrethrum | 50 | 5 | Dusted. | 48 | 88 | 96 | 100 | ..... | ..... | ..... | ..... |
| 33a | Amianthium | 20 | 2 | Fed.... | 15 | 60 | 100 | ..... | ..... | ..... | ..... | ..... |
| 33b | Do | 20 | 2 | ...do... | 10 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| 110 | Derris | 40 | 4 | Dusted. | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control | 90 | 9 | ..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Flies: | | | | | | | | | | | |
| 33a | Amianthium | 10 | 1 | Dusted. | 0 | 20 | 60 | 80 | 100 | ..... | ..... | ..... |
| 33b | Do | 10 | 1 | ...do... | 0 | 10 | 50 | 70 | 100 | ..... | ..... | ..... |
| 33a | Do | 10 | 1 | Fed.... | 0 | 40 | 60 | 70 | 100 | ..... | ..... | ..... |
| 33b | Do | 10 | 1 | ...do... | 0 | 20 | 30 | 40 | 90 | 100 | ..... | ..... |
| 11 | Tomato[7] | 100 | 5 | ...do... | 0 | 12 | 52 | 60 | 96 | 100 | ..... | ..... |
| 110 | Derris[8] | (9) | ..... | Dusted. | ..... | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| 103 | Pyrethrum | 6 | 1 | ...do... | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control | 100 | 5 | ..... | 0 | 5 | 28 | 28 | 33 | ..... | ..... | ..... |
| | Honeybees: | | | | | | | | | | | |
| 109 | Hellebore | 40 | 2 | Dusted. | 3 | 68 | 68 | ..... | ..... | ..... | ..... | ..... |
| 35f | Amianthium | 20 | 1 | ...do... | 15 | 50 | 100 | ..... | ..... | ..... | ..... | ..... |
| 56 | Sabadilla | 40 | 2 | ...do... | 50 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control | 40 | 2 | ..... | 0 | 0 | 0 | ..... | ..... | ..... | ..... | ..... |
| | Potato-beetle larvæ: | | | | | | | | | | | |
| 110 | Derris | 100 | 1 | Dusted. | 25 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| 501 | "Cube" | 100 | 1 | ...do... | 25 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| 103 | Pyrethrum | 100 | 1 | ...do... | 50 | 100 | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control | 100 | 1 | ..... | 0 | 0 | ..... | ..... | ..... | ..... | ..... | ..... |

[1] Where a test did not continue for 7 days, columns are left blank.
[2] No. 200 powder from bulbs.
[3] No. 200 powder from leaves.
[4] No. 100 powder, oil extracted.
[5] No. 40 powder, oil extracted.
[6] No. 40 powder, oil not extracted.
[7] No. 60 powder from vines.
[8] From derris paper (*61*).
[9] Many.

TABLE 2.—*Comparative results obtained by dusting aphids with various powders.*

| Sample No. | Species and preparation. | Estimated number of individuals. | Number of sets. | Percentage of aphids dead within—[1] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 6 hours. | 1 day. | 2 days. | 3 days. | 4 days. |
| | Aphis sp. B: | | | | | | | |
| 56 | Sabadilla[2] | 100 | 1 | 0 | 5 | 10 | 40 | ..... |
| 113 | Do[3] | 100 | 1 | 0 | 5 | 10 | 40 | ..... |
| 23k | Chinaberry[4] | 100 | 1 | 0 | 10 | 25 | 50 | ..... |
| 33a | Amianthium[5] | 100 | 1 | ..... | ..... | 15 | 25 | ..... |
| 33b | Do[4] | 100 | 1 | ..... | ..... | 5 | 50 | ..... |
| 35e | Do[4] | 100 | 1 | ..... | ..... | 25 | 50 | ..... |
| 35f | Do[5] | 100 | 1 | ..... | ..... | 75 | 80 | ..... |
| 502 | Hellebore | 100 | 1 | ..... | ..... | 10 | 40 | ..... |
| 103 | Pyrethrum | 100 | 1 | 95 | 100 | ..... | ..... | ..... |
| 110 | Derris | 100 | 1 | 25 | ..... | 100 | ..... | ..... |
| 501 | "Cube" | 100 | 1 | 15 | ..... | 100 | ..... | ..... |

[1] Where a test did not continue for 4 days columns are left blank.
[2] Oil extracted.
[3] Oil not extracted.
[4] No. 200 powder of leaves.
[5] No. 200 powder of bulbs.

TABLE 2.—*Comparative results obtained by dusting aphids with various powders*—Continued.

| Sample No. | Species and preparation. | Estimated number of individuals. | Number of sets. | Percentage of aphids dead within— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 6 hours. | 1 day. | 2 days. | 3 days | 4 days. |
| | Aphis sp. A: | | | | | | | |
| 103 | Pyrethrum | 100 | 1 | 95 | 100 | | | |
| 110 | Derris | 100 | 1 | 25 | | 100 | | |
| 501 | "Cube" | 100 | 1 | 10 | | 100 | | |
| | Macrosiphum sp. A: | | | | | | | |
| 521 | Hura crepitans [1] | 500 | 1 | 20 | 20 | 80 | | |
| 522 | Do [2] | 500 | 1 | 20 | 30 | 80 | | |
| 503 | Pyrethrum | 1,500 | 3 | 86 | 88 | 98 | 100 | |
| 110 | Derris | 1,000 | 2 | 20 | 50 | 75 | 85 | 92 |
| 501 | "Cube" | 1,500 | 3 | 20 | 43 | 70 | 83 | 97 |
| | Macrosiphum sp. B: | | | | | | | |
| 503 | Pyrethrum | 100 | 1 | 99 | 100 | | | |
| | Macrosiphum solanifolii: | | | | | | | |
| 501 | "Cube" | 300 | 1 | | 99 | 100 | | |
| | Aphis rumicis: | | | | | | | |
| 501 | "Cube" | 200 | 1 | 50 | 98 | 100 | | |
| | Macrosiphonella sanborni: | | | | | | | |
| 103 | Pyrethrum | 1,000 | 2 | 99 | 100 | | | |
| 110 | Derris | 500 | 1 | | | | | 100 |

[1] No. 200 powder of bark. [2] No. 200 powder of sawdust.

TABLE 3.—*Comparative results obtained by testing various powders against aphids in the form of fumigants, decoctions, infusions, and hot-water extracts.*

| Sample No. | Preparation and how used. | Insects tested. | | | Percentage of aphids dead within—[1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | Estimated number of individuals. | Number of sets. | Species. | 6 hours. | 1 day. | 2 days. | 3 days. |
| | Fumigant: | | | | | | | |
| 56 | Sabadilla burned | 100 | 1 | Macrosiphum sp. C | 95 | 98 | | |
| 502 | Hellebore burned | 100 | 1 | do | | 75 | | |
| 103 | Pyrethrum burned | 100 | 1 | do | 100 | 100 | | |
| 110 | Derris burned | 100 | 1 | do | | 100 | | |
| 501 | "Cube" burned | 100 | 1 | do | | 100 | | |
| 113 | Sabadilla burned | 100 | 1 | Myzus persicae | 98 | 100 | | |
| 103 | Pyrethrum burned | 100 | 1 | do | 100 | 100 | | |
| 110 | Derris burned | 100 | 1 | do | | 95 | | |
| | Decoction not filtered: | | | | | | | |
| 56a | Sabadilla sprayed | 100 | 1 | Aphis sp. B | 0 | 0 | 5 | 10 |
| 301a | Chinaberry sprayed | 100 | 1 | do | 0 | 0 | 0 | 5 |
| 35fa | Amianthium sprayed | 100 | 1 | do | 0 | 5 | 10 | 25 |
| 502a | Hellebore sprayed | 100 | 1 | do | 0 | 0 | 0 | 5 |
| 103a | Pyrethrum sprayed | 100 | 1 | do | 50 | 85 | 95 | 100 |
| 110a | Derris sprayed | 100 | 1 | do | 0 | 50 | 90 | 99 |
| 501a | "Cube" sprayed | 100 | 1 | do | 0 | 50 | 80 | 90 |
| 103a | Pyrethrum sprayed | 100 | 1 | Aphis sp. A | 50 | 95 | 99 | 100 |
| 110a | Derris sprayed | 100 | 1 | do | 0 | 50 | 90 | 99 |
| 501a | "Cube" sprayed | 100 | 1 | do | 0 | 40 | 50 | 95 |
| | Water extract (decoction filtered): | | | | | | | |
| 103b | Pyrethrum sprayed | 100 | 1 | do | 0 | 0 | | |
| 103b | Do | 100 | 1 | Aphis sp. B | 0 | 2 | | |
| 110b | Derris sprayed | 100 | 1 | do | 5 | 60 | | |
| 110b | Do | 100 | 1 | Aphis sp. A | 5 | 60 | | |
| 501b | "Cube" sprayed | 100 | 1 | do | 10 | 95 | | |
| 501b | Do | 100 | 1 | Aphis sp. B | 5 | 98 | | |
| | Infusion not filtered: | | | | | | | |
| 501c | "Cube" sprayed | 200 | 1 | Aphis rumicis | | 98 | | |
| 501c | Do | 600 | 1 | Macrosiphum solanifolii | | 99 | | |

[1] Where a test did not continue for 3 days, columns are left blank.

TABLE 4.—*Comparative results obtained by spraying aphids with the alcoholic and benzene extracts derived from various powders.*

| Sample No. | Preparation. | Insects tested. | | | Percentage of aphids dead within—[1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | Estimated number of individuals. | Number of sets. | Species. | 6 hours. | 1 day. | 2 days. | 3 days. |
| | Alcoholic extract+soap+water (2+4+100): | | | | | | | |
| 510 | Sabadilla | 100 | 1 | Aphis sp. A | | 20 | 40 | |
| 510 | Do | 100 | 1 | Aphis sp. B | | 30 | 60 | |
| 505 | Chinaberry | 100 | 1 | Aphis sp. A | | 30 | 90 | |
| 505 | Do | 100 | 1 | Aphis sp. B | | 40 | 95 | |
| 504 | Amianthium | 100 | 1 | Aphis sp. A | | 40 | 75 | |
| 504 | Do | 100 | 1 | Aphis sp. B | | 60 | 75 | |
| 511 | Castor bean | 100 | 1 | Aphis sp. A | | 30 | 50 | |
| 511 | Do | 100 | 1 | Aphis sp. B | | 20 | 40 | |
| 508 | Hellebore | 100 | 1 | Aphis sp. A | | 30 | 75 | |
| 508 | Do | 100 | 1 | Aphis sp. B | | 40 | 70 | |
| 509 | Pyrethrum | 100 | 1 | Aphis sp. A | | 95 | 100 | |
| 509 | Do | 100 | 1 | Aphis sp. B | | 95 | 100 | |
| 507 | Derris | 100 | 1 | Aphis sp. A | | 95 | 100 | |
| 507 | Do | 100 | 1 | Aphis sp. B | | 95 | 99 | 100 |
| 506 | "Cube" | 100 | 1 | Aphis sp. A | | 95 | 100 | |
| 506 | Do | 100 | 1 | Aphis sp. B | | 100 | | |
| | Control, alcohol+soap+water (2+4+100) | 100 | 1 | Aphis sp. A | | 10 | 25 | |
| | Do | 100 | 1 | Aphis sp. B | | 10 | 15 | |
| | Alcoholic extract+soap+water (8+2+100): | | | | | | | |
| 510 | Sabadilla | 500 | 1 | Macrosiphum sp. A | 10 | 50 | 55 | 55 |
| 505 | Chinaberry | 500 | 1 | ....do | 5 | 10 | 20 | 25 |
| 504 | Amianthium | 500 | 1 | ....do | 5 | 10 | 20 | 30 |
| 511 | Castor bean | 500 | 1 | ....do | 30 | 50 | 60 | 75 |
| 508 | Hellebore | 500 | 1 | ....do | 50 | 75 | 80 | 85 |
| | Control, alcohol+soap+water (4+2+100) | 500 | 1 | ....do | 5 | 15 | 15 | 15 |
| | Benzene extract+soap+water (8+2+100): | | | | | | | |
| 519 | Sabadilla | 500 | 1 | ....do | 50 | 85 | 90 | |
| 514 | Chinaberry | 500 | 1 | ....do | 60 | 85 | 85 | |
| 513 | Amianthium | 500 | 1 | ....do | 50 | 75 | 85 | |
| 520 | Castor bean | 500 | 1 | ....do | 70 | 95 | 99 | |
| 517 | Hellebore | 500 | 1 | ....do | 60 | 85 | 90 | |
| | Control, benzene+soap+water (8+2+100) | 500 | 1 | ....do | 50 | 50 | 50 | |
| | 40 per cent nicotine sulphate (1/1200)+soap+water (0.8+2+100) | 1,500 | 3 | ....do | 91 | 95 | 97 | 100 |

[1] Where a test did not continue for 3 days, columns are left blank.

TABLE 5.—*Comparative results obtained by spraying Macrosiphum sp. A with alcoholic and benzene extracts derived from "cube," derris, and pyrethrum, and with 40 per cent nicotine sulphate.*

| Preparation. | Aphids sprayed with alcoholic extracts. | | | | | | Aphids sprayed with benzene extracts. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of sets. | Estimated number of individuals. | Percentage of aphids dead within—[1] | | | | Percentage of aphids dead within—[1] | | | | Number of sets. | Estimated number of individuals. |
| | | | 6 hours. | 1 day. | 2 days. | 3 days. | 6 hours. | 1 day. | 2 days. | 3 days. | | |
| Extract+water (4+100): | | | | | | | | | | | | |
| "Cube" | 1 | 500 | 50 | 95 | 100 | | | | | | | |
| Derris | 1 | 500 | 50 | 85 | 90 | 95 | | | | | | |
| Pyrethrum | 1 | 500 | 60 | 80 | 85 | 90 | | | | | | |
| Extract+soap+water (4+2+100): | | | | | | | | | | | | |
| "Cube" | 3 | 1,680 | 99 | 100 | | | | | | | | |
| Derris | 3 | 1,500 | 98 | 100 | | | | | | | | |
| Pyrethrum | 3 | 1,700 | 97 | 98 | 100 | | | | | | | |
| Extract+soap+water (2+2+100): | | | | | | | | | | | | |
| Pyrethrum | 1 | 500 | 90 | 95 | 100 | | | | | | | |
| Derris | 1 | 500 | 100 | | | | | | | | | |
| "Cube" | 1 | 500 | 99 | 100 | | | | | | | | |
| Extract+soap+water (1+2+100): | | | | | | | | | | | | |
| "Cube" | 5 | 2,500 | 100 | | | | 98 | 98 | 100 | | 1 | 500 |
| Derris | 4 | 2,000 | 99 | 100 | | | 98 | 98 | 100 | | 1 | 500 |
| Pyrethrum | 4 | 2,000 | 62 | 76 | 80 | | 60 | 85 | 85 | | 1 | 500 |
| Extract+soap+water (3/4+2+100): | | | | | | | | | | | | |
| Pyrethrum | 1 | 500 | 30 | 60 | 70 | | | | | | | |
| Derris | 1 | 500 | 93 | 98 | 100 | | | | | | | |
| "Cube" | 1 | 500 | 100 | | | | | | | | | |
| Extract+soap+water (1/2+2+100): | | | | | | | | | | | | |
| "Cube" | 6 | 3,000 | 98 | 100 | | | 98 | 98 | 100 | | 2 | 1,000 |
| Derris | 5 | 2,500 | 93 | 97 | 100 | | 95 | 97 | 99 | | 2 | 1,000 |
| Pyrethrum | 1 | 500 | 25 | 40 | 50 | | 50 | 60 | 85 | | 1 | 500 |
| Extract+soap+water (1/3+2+100): | | | | | | | | | | | | |
| Derris | 4 | 2,000 | 77 | 82 | 89 | 95 | 50 | 85 | 92 | | 1 | 500 |
| "Cube" | 5 | 2,500 | 95 | 99 | 100 | | 90 | 96 | 97 | | 1 | 500 |
| Extract+soap+water (1/4+2+100): | | | | | | | | | | | | |
| "Cube" | 5 | 2,500 | 96 | 99 | 100 | | 90 | 90 | 93 | | 1 | 500 |
| Derris | 2 | 1,000 | 60 | 62 | 70 | 80 | 50 | 60 | 60 | | 1 | 500 |
| Extract+soap+water (1/5+2+100) "cube" | 2 | 1,000 | 93 | 97 | 99 | 100 | | | | | | |
| Extract+soap+water (1/6+2+100) "cube" | 3 | 1,500 | 93 | 97 | 99 | 100 | | | | | | |
| 40 per cent nicotine sulphate (1/400)+soap+water (2.5+2+100) | 6 | 3,000 | 98 | 99 | 100 | | | | | | | |
| 40 per cent nicotine sulphate (1/800)+soap+water (1.25+2+100) | 6 | 3,000 | 95 | 98 | 100 | | | | | | | |
| 40 per cent nicotine sulphate (1/1,200)+soap+water (0.8+2+100) | 3 | 1,500 | 91 | 95 | 97 | 100 | | | | | | |

[1] Where a test did not continue for 3 days, columns are left blank.

TABLE 5.—*Comparative results obtained by spraying Macrosiphum sp. A with alcoholic and benzene extracts derived from "cube," derris, etc.*—Continued.

| Preparation. | Aphids sprayed with alcoholic extracts. | | | | | | Aphids sprayed with benzene extracts. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of sets. | Estimated number of individuals. | Percentage of aphids dead within— | | | | Percentage of aphids dead within— | | | | Number of sets. | Estimated number of individuals. |
| | | | 6 hours. | 1 day. | 2 days. | 3 days. | 6 hours. | 1 day. | 2 days. | 3 days. | | |
| Control, solvent +soap+water (4+2+100)... | 1 | 500 | 5 | 15 | 15 | 15 | ..... | ..... | ..... | ..... | ..... | ..... |
| Control, solvent +soap+water (2+2+100)... | 1 | 500 | 5 | 15 | 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Control, solvent +soap+water (1+2+100)... | 3 | 1,500 | 5 | 12 | 13 | ..... | 10 | 10 | 15 | ..... | 1 | 500 |
| Control, solvent +soap+water (1/2+2+100).. | 2 | 1,000 | 5 | 10 | 12 | ..... | 5 | 15 | 15 | ..... | 1 | 500 |

TABLE 6.—*Comparative results obtained by spraying 11 species of aphids with alcoholic extracts derived from "cube," derris, and pyrethrum, and with 40 per cent nicotine sulphate, mixed with soap solution and kerosene emulsion.*

| Sample No. | Preparation. | Percentage of aphids dead within 24 hours. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Macrosiphum sp. A. | Macrosiphum rosæ. | Macrosiphum solanifolii. | Macrosiphum sp. C. | Aphis sp. A. | Aphis sp. B. | Aphis sp. E. | Aphis spiræcola. | Macrosiphonella sanborni. | Aphis sp. C. | Aphis sp. D. |
| | Alcoholic extract+soap+water: | | | | | | | | | | | |
| 509 | 8+4+100, Pyrethrum | ..... | ..... | 95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 4+4+100— | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 90 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | ..... | ..... | 95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 4+2+100— | | | | | | | | | | | |
| 509 | Pyrethrum | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 2+4+100— | | | | | | | | | | | |
| 506 | "Cube" | ..... | ..... | ..... | ..... | 95 | 100 | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | ..... | ..... | 95 | 95 | ..... | ..... | ..... | ..... | ..... |
| 509 | Pyrethrum | ..... | ..... | ..... | ..... | 95 | 95 | ..... | ..... | ..... | ..... | ..... |
| 509 | 2+2+100— | | | | | | | | | | | |
| | Pyrethrum | 95 | 92 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | 100 | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | 100 | 100 | 50 | 90 | ..... | ..... | 90 | ..... | ..... | ..... | ..... |
| | 1+2+100— | | | | | | | | | | | |
| 506 | "Cube" | 100 | 100 | ..... | ..... | ..... | ..... | 40 | 95 | ..... | ..... | ..... |
| 507 | Derris | 100 | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 509 | Pyrethrum | 76 | 89 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 3/4+2+100— | | | | | | | | | | | |
| 509 | Pyrethrum | 60 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/2+2+100— | | | | | | | | | | | |
| 506 | "Cube" | 100 | 100 | ..... | ..... | ..... | ..... | 40 | 90 | ..... | ..... | ..... |
| 507 | Derris | 97 | 95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 509 | Pyrethrum | 40 | 86 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/3+2+100— | | | | | | | | | | | |
| 507 | Derris | 82 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/4+2+100— | | | | | | | | | | | |
| 506 | "Cube" | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | 62 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/5+2+100— | | | | | | | | | | | |
| 506 | "Cube" | 97 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/6+2+100— | | | | | | | | | | | |
| 506 | "Cube" | 97 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

TABLE 6.—*Comparative results obtained by spraying 11 species of aphids with alcoholic extracts derived form "cube," derris, and pyrethrum, etc.*—Contd.

| Sample No. | Preparation. | Percentage of aphids dead within 24 hours. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Macrosiphum sp. A. | Macrosiphum rosae. | Macrosiphum solanifolii. | Macrosiphum sp. C. | Aphis sp. A. | Aphis sp. B. | Aphis sp. E. | Aphis spiraecola. | Macrosiphonella sanborni. | Aphis sp. C. | Aphis sp. D. |
| | 40 per cent nicotine sulphate: | | | | | | | | | | | |
| | 1/400 + soap + water (2.5+2+100) | 99 | 100 | 75 | 90 | ..... | ..... | 99 | ..... | ..... | ..... | ..... |
| | 1/800 + soap + water (1.25+2+100) | 98 | 92 | 60 | 85 | ..... | ..... | 99 | ..... | ..... | ..... | ..... |
| | 1/1200 + soap + water (0.8+2+100) | 95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/400 + soap + water (2.5+4+100) | ..... | ..... | 95 | ..... | ..... | ..... | ..... | ..... | 100 | ..... | ..... |
| | 1/800 + soap + water (1.25+4+100) | ..... | ..... | 95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control, alcohol+soap+water: | | | | | | | | | | | |
| | 4+2+100 | 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 2+2+100 | 15 | ..... | 0 | 5 | ..... | ..... | 10 | 20 | ..... | ..... | ..... |
| | 1+2+100 | 12 | 25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 1/2+2+100 | 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 2+4+100 | ..... | ..... | 5 | ..... | 10 | 10 | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (1+100)+10 per cent kerosene emulsion: | | | | | | | | | | | |
| 506 | "Cube" | ..... | ..... | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (2+100)+10 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (2+100)+5 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (1+100)+5 per cent kerosene emulsion: | | | | | | | | | | | |
| 507 | Derris | ..... | ..... | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | ..... | ..... | 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Control, alcohol+water (2+100)+: | | | | | | | | | | | |
| | 10 per cent kerosene emulsion | ..... | ..... | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 5 per cent kerosene emulsion | ..... | ..... | 65 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 2.5 per cent kerosene emulsion | ..... | ..... | 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (1+100)+2.5 per cent kerosene emulsion: | | | | | | | | | | | |
| 506 | "Cube" | ..... | ..... | 99 | 98 | ..... | ..... | 92 | ..... | ..... | 98 | 98 |
| 507 | Derris | ..... | ..... | 98 | 100 | ..... | ..... | 88 | ..... | ..... | 90 | 97 |
| | Alcoholic extract+water (2+100)+2.5 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (1+100)+2.5 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 95 | 65 | ..... | ..... | 70 | ..... | ..... | 60 | 95 |
| | Alcoholic extract+water (2+100)+1.25 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract+water (1+100)+1.25 per cent kerosene emulsion: | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | 98 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | ..... | ..... | 99 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

TABLE 6.—*Comparative results obtained by spraying 11 species of aphids with alcoholic extracts derived form "cube," derris, and pyrethrum, etc.*—Contd.

| Sample No. | Preparation. | Percentage of aphids dead within 24 hours. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Macrosiphum sp. A. | Macrosiphum rosae. | Macrosiphum solanifolii. | Macrosiphum sp. C. | Aphis sp. A. | Aphis sp. B. | Aphis sp. E. | Aphis spiraecola. | Macrosiphonella sanborni. | Aphis sp. C. | Aphis sp. D. |
| | Alcoholic extract+water (1/2+100)+1.25 per cent kerosene emulsion: | | | | | | | | | | | |
| 506 | "Cube" | ..... | ..... | 90 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | 80 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 509 | Pyrethrum | ..... | ..... | 50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Alcoholic extract + soap+ water (1+4+100): | | | | | | | | | | | |
| 509 | Pyrethrum | ..... | ..... | 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 507 | Derris | ..... | ..... | 20 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 506 | "Cube" | ..... | ..... | 20 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

TABLE 7.—*Comparative results obtained by spraying aphids with various extracts derived from "cube."*

| Sample No. | Preparation. | Insects tested. | | | Percentage of aphids dead within —[1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | Estimated number of individuals. | Number of sets. | Species. | 6 hours. | 1 day. | 2 days. | 3 days. |
| | Alcoholic extract + soap+water: | | | | | | | |
| | 2+2+100— | | | | | | | |
| 506 | Cold | 500 | 1 | Aphis sp. E | 60 | 90 | 95 | 95 |
| 525 | Hot | 300 | 1 | .....do | 50 | 60 | 65 | 75 |
| | 1+2+100— | | | | | | | |
| 525 | Hot | 300 | 1 | .....do | 30 | 40 | 50 | 60 |
| 506 | Cold | 300 | 1 | .....do | 30 | 40 | 50 | 60 |
| 506 | Cold | 2,500 | 5 | Macrosiphum sp. A | 100 | ..... | ..... | ..... |
| 525 | Hot | 500 | 1 | .....do | 100 | ..... | ..... | ..... |
| | 1/2+2+100— | | | | | | | |
| 525 | Hot | 500 | 1 | .....do | 100 | ..... | ..... | ..... |
| 506 | Cold | 3,000 | 6 | .....do | 98 | 100 | ..... | ..... |
| | 1/3+2+100— | | | | | | | |
| 506 | Cold | 2,500 | 5 | .....do | 95 | 99 | 100 | ..... |
| 525 | Hot | 500 | 1 | .....do | 100 | ..... | ..... | ..... |
| | 1/4+2+100— | | | | | | | |
| 525 | Hot | 500 | 1 | .....do | 100 | ..... | ..... | ..... |
| 506 | Cold | 2,500 | 5 | .....do | 96 | 99 | 100 | ..... |
| | 1/6+2+100— | | | | | | | |
| 506 | Cold | 1,500 | 3 | .....do | 97 | 99 | 100 | ..... |
| 525 | Hot | 500 | 1 | .....do | 95 | 100 | ..... | ..... |
| | Resin dissolved in alcohol+soap+water: | | | | | | | |
| 526 | 2+2+100 | 800 | 2 | Aphis sp. E | 35 | 55 | 60 | 65 |
| 526 | 1+2+100 | 600 | 2 | .....do | 15 | 15 | 20 | 30 |
| 526 | 1/2+2+100 | 300 | 1 | .....do | 10 | 10 | 15 | 20 |
| 526 | 2+4+100 | 500 | 1 | Macrosiphum solanifolii | ..... | 75 | ..... | ..... |
| 526 | 2+2+100 | 500 | 1 | .....do | 30 | 40 | 40 | ..... |
| 526 | 2+2+100 | 100 | 1 | Macrosiphum sp. C | 60 | 60 | ..... | ..... |
| 526 | 1+2+100 | 300 | 1 | Aphis spiraecola | 40 | 50 | 60 | ..... |
| 526 | 1/2+2+100 | 300 | 1 | .....do | 40 | 40 | 50 | ..... |
| | Filtrate from No. 506 +soap+water: | | | | | | | |
| 527 | 2+4+100 | 500 | 1 | Macrosiphum solanifolii | 5 | 5 | 5 | ..... |
| 527 | 2+2+100 | 500 | 1 | .....do | 5 | 5 | 5 | ..... |
| 527 | 2+2+100 | 100 | 1 | Macrosiphum sp. C | 10 | 10 | ..... | ..... |
| 527 | 2+2+100 | 500 | 1 | Aphis sp. E | 20 | 30 | 30 | 35 |
| | Cold water extract+ soap+water: | | | | | | | |
| 528 | 2+4+100 | 500 | 1 | Macrosiphum solanifolii | 5 | 5 | 5 | ..... |
| 528 | 2+2+100 | 500 | 1 | .....do | 5 | 5 | 5 | ..... |
| 528 | 2+2+100 | 100 | 1 | Macrosiphum sp. C | 10 | 10 | ..... | ..... |
| 528 | 2+2+100 | 500 | 1 | Aphis sp. E | 10 | 10 | 10 | ..... |

[1] Where a test did not continue for 3 days, columns are left blank.

TABLE 8.—*Effects of spraying aphids with the sap and alcoholic extracts of Hura crepitans.*

| Sample No. | Preparation. | Insects tested. | | | Percentage of aphids dead within—[1] | | | |
|---|---|---|---|---|---|---|---|---|
| | | Estimated number of individuals. | Number of sets. | Species. | 6 hours. | 1 day. | 2 days. | 3 days. |
| 500 | Sap 10 per cent | 100 | 1 | Aphis sp. A | 0 | 40 | 60 | 95 |
| 500 | Do | 100 | 1 | Aphis sp. B | 0 | 60 | 70 | 99 |
| 512 | Sap 20 per cent | 500 | 1 | Macrosiphum sp. A | 5 | 50 | 60 | 95 |
| 500a | Sap + soap + water (5 per cent+4+100). | 100 | 1 | Aphis sp. A | | 30 | 60 | |
| 500a | Do | 100 | 1 | Aphis sp. B | | 20 | 50 | |
| 512a | Sap + soap + water (10 per cent+2+100). | 2,000 | 4 | Macrosiphum sp. A | 29 | 70 | 84 | 92 |
| | Control, soap+water (2+100). | 500 | 1 | do | 5 | 10 | 15 | 15 |
| | Control, soap+water (4+100). | 100 | 4 | Aphis sp. A | | 10 | 25 | |
| | Do | 100 | 1 | Aphis sp. B | | 10 | 15 | |
| 523 | Alcoholic extract of bark + soap + water (2+2+100). | 1,000 | 2 | Macrosiphum sp. A | 30 | 55 | 92 | |
| 524 | Alcoholic extract of sawdust + soap + water (2+2+100). | 1,000 | 2 | do | 20 | 30 | 50 | |
| | Control, alcohol + soap+water (2+2+100). | 500 | 1 | do | 5 | 15 | 15 | |
| | 40 per cent nicotine sulphate (1/1200)+ soap+water (0.8+2+100). | 1,500 | 3 | do | 91 | 95 | 97 | 100 |

[1] Where no test was taken, and where a test continued only 2 days, blanks are left.

## DISCUSSION OF THE LESS IMPORTANT RESULTS OBTAINED.

A powder and decoction of the common yarrow (*Achillea millefolium*) had no effect on the aphids (*Macrosiphum* sp. *B*) tested.

The roots, leaves, and stems of Columbia monkshood (*Aconitum columbianum*), used as a stomach poison, had no effect on grasshoppers; and used as a dust, they had no effect on bees.

The leaves of a peach tree (*Amygdalus persica*), wet with the juice of mulberry-tree leaves, were fed to silkworms, and within 24 hours after eating this food practically all of the insects were dead.

A water extract of añiliton (see footnote on p. 26) had no effect on silkworms.

Cold and hot water extracts of sagebrush (*Artemisia tridentata*) had no effect on silkworms, webworms, potato-beetle larvæ, rose aphids, and nasturtium aphids, but these extracts slowly killed bees.

A water extract of añiliton (see footnote on p. 26) had no effect against small webworms and small catalpa caterpillars. Water and alcoholic extracts were efficient against bees. The powder, used as a fumigant, had no effect against small webworms; used as a dust, it had a slight effect on tent caterpillars and roaches; and used as a stomach poison, it had no effect on webworms and flies and only a slight effect on roaches and silkworms.

A water extract of balbec (see footnote on p. 26) killed silkworms quickly.

The juice, highly concentrated, from the green leaves and beans of catalpa (*Catalpa bignonioides*) had a slight effect on bees.

A water extract from the dried leaves and seeds of the American wormseed (*Chenopodium ambrosioides*) had no effect on bees. A strong decoction, mixed with soap, from the leaves, stems, and seeds had no effect on potato aphids and nasturtium aphids. The powder, used as a dust, had no effect on tent caterpillars, but a considerable effect on roaches; and used as a stomach poison, it had no effect on grasshoppers.

The powder and hot-water extract from the flower heads of the oxeye daisy (*Chrysanthemum leucanthemum*) had no effect on silkworms, webworms, potato-beetle larvæ, and rose aphids.

The powder from *Clibadium surinamense* had practically no effect on silkworms.

A hot-water extract of the stems of a fish-poison (*Cracca villosa purpurea*) had no effect on tent caterpillars.

Cold-water extracts from the tops of Scotch broom (*Cytisus scoparius*), collected in two different localities, had practically no effect on silkworms. Since this plant is reported to contain sparteine, a 0.5 per cent solution of sparteine sulphate was fed to silkworms. This solution proved efficient, but acted very slowly.

A water extract of jimsonweed (*Datura stramonium*) had no effect against small webworms and small catalpa caterpillars, and a highly concentrated water extract had only a slight effect on bees. The water extract, used as a fumigant, had no effect on small webworms. The powder, used as a stomach poison, had a slight effect on silkworms; and used as a dust, it had a slight effect on roaches and tent caterpillars.

Powders from the roots, leaves, and stems, and from the blossoms of low larkspur (*Delphinium bicolor*), and hot-water extracts from all of these powders had no effect on webworms, silkworms, grasshoppers, and potato-beetle larvæ, with one exception: the extract from the blossoms had a slight effect on silkworms.

A water extract from *Euphorbia cotinoides* had a considerable effect on silkworms.

A water extract from *Furcraea cubensis* had practically no effect on silkworms.

A powder and a decoction from galinsoga (*Galinsoga parviflora*) had no effect on the aphids (*Macrosiphum* sp. *B*) tested.

The juice from the green leaves of the Kentucky coffeetree (*Gymnocladus dioica*), mixed separately with sugar sirup, molasses, and honey, had no apparent effect on the many flies tested.

The powder from the heads of the bitterweed (*Helenium tenuifolium*) had only a very slight effect on silkworms, flies, and aphids (*Aphis* spp. *A* and *B*), but the decoction had no effect whatever on aphids of the same species.

A water extract from a Honduras fish-poison (see footnote on p. 26) was efficient against silkworms.

A powder from *Jatropha macrorhiza*, used as a dust, had a slight effect on tent caterpillars and roaches.

The powder from lambkill (*Kalmia angustifolia*), eaten by grasshoppers and dusted upon bees, had no effect.

The powder and a water extract from margarita (*Karwinskia humboldtiana*) were efficient but very slow against silkworms, although they had no effect on tulip-tree aphids. The powder had

a slight effect on catalpa caterpillars, while an alcoholic extract from it had no effect on small webworms and tulip-tree aphids.

A water extract of lancepod (*Lonchocarpus* sp.) had no effect on silkworms.

The powder from the common matrimony-vine (*Lycium halimifolium*), used as a dust, affected roaches considerably, but tent caterpillars only slightly; and used as a stomach poison, it had a considerable effect on grasshoppers. The water extract did not affect bees.

A commercial powder containing *Madhuca* sp. seeds was tested and found efficient but slow against silkworms, although within 48 hours it killed only about 35 per cent of the *Aphis* spp. *A* and *B* tested. A decoction of the powder had only a slight effect on the same species of aphids.

A water extract of the wood of moetoepoe (see footnote on p. 26) proved to be efficient, while a water extract of the leaves was found to be inefficient against silkworms.

A water extract of the leaves of necoetae (see footnote on p. 26) killed silkworms very slowly.

The powder from the leaves and stems of the common oleander (*Nerium oleander*) and a decoction from this powder had no effect on aphids (*Macrosiphum* sp. *B*).

An infusion and a decoction of the leaves of tree tobacco (*Nicotiana glauca*) with soap (1 pound to 50 gallons of water) had only a very slight effect on nasturtium aphids, while the powdered leaves had no apparent effect on them. (An analysis of some of the leaves, made by a chemist of a tobacco by-products company, showed that the nicotine content, upon a moisture-free basis, amounted to only 0.18 of 1 per cent).

The hot and cold water extracts of the bark and leaves of *Pangium edule* were found to be inefficient against tent caterpillars. The extracts from the bark appeared a little better than those from the leaves.

Neither the exhalation nor decoction from the green leaves of *Pongam pinnata* had any effect on nasturtium aphids.

A hot-water extract from the green tops of the American elder (*Sambucus canadensis*) had no effect on silkworms, webworms, or rose aphids.

A powder and a decoction from the whitetop-aster (*Sericocarpus asteroides*) had no effect on the aphids (*Macrosiphum* sp. *B*) tested.

The water extract of the horsenettle (*Solanum carolinense*) had no effect against small webworms and small catalpa caterpillars. The powder, used as a fumigant, had no effect against small catalpa caterpillars; used as a stomach poison, it had no effect against silkworms and webworms, but had a slight effect on grasshoppers; and used as a dust, it had a slight effect on tent caterpillars and roaches.

The powder from sleepy grass (*Stipa viridula*), used as a dust, had no effect on tent caterpillars, but had a slight effect on roaches.

A water extract of the bark of suma rubra (see footnote on p. 26) had a slight effect against silkworms.

A water extract of tssikoena (see footnote on p. 26) had a slight effect against silkworms.

The powdered roots of *Veratrum californicum* had no effect on grasshoppers.

The powder from the moth mullein (*Verbascum blattaria*), used as a dust, had a slight effect on roaches and tent caterpillars; used as a stomach poison, it had a very slight effect on grasshoppers and flies, but none at all on roaches, silkworms, and webworms. The water extract had no effect on webworms, potato-beetle larvæ, and rose aphids, but a slight effect on bees and silkworms. An alcoholic extract was fatal to bees.

The powders from the roots, stems, and leaves of zygadenus (*Zygadenus venenosus*) and hot-water extracts from these powders, had no effect on grasshoppers, webworms, and potato-beetle larvæ, and only a slight effect on silkworms.

## CATALOGUE OF PLANTS TESTED FOR OR REPORTED TO POSSESS INSECTICIDAL PROPERTIES.

In 1919 Roark (*75*) catalogued and published the names of nearly 200 species of plants which had been tested for or reported to possess insecticidal properties. The present writers have been collecting the literature on this subject since 1915, but certainly would have overlooked some of the references had it not been for Roark's publication, which is not available for the average agricultural reader. The writers have verified, revised, and enlarged Roark's catalogue, and now it includes in all 267 species of plants, although 7 of these may be synonyms. The purpose of this catalogue is to serve as a handy reference and to encourage research along this line of work.

Relative to the best-known plant insecticides, only a few references are given, but in regard to the little-known ones all the references that could be found are included. To avoid duplications concerning the plants tested by the writers, the reader is merely referred to the pages on which the writer's results are given, and to facilitate finding all the information about any given species given in this bulletin, the reader is referred to the "Index of the botanical and common names of plants catalogued" on pages 59–61.

**Achillea millefoliam** L. ASTERACEAE. **Common yarrow.** Europe, Asia, North America.

The writers' results are given on page 21.

**Achillea nobilis** L. **Camphor yarrow.** Europe.

Gieseler (*26*) reports that the flower heads have an action on insects similar to that of insect powder.

**Aconitum columbianum** Nutt. RANUNCULACEAE. **Columbia monkshood.** Western North America.

The writers' results are given on page 21.

**Aconitum napellus** L. **Aconite.** Old World.

Gomilevsky (*28*) determined that a few drops of a strong water extract, dropped upon the body of a stag beetle (*Lucanus cervus*), were fatal.

**Aeschrion excelsa** (Swartz) Kuntze. SIMARUBACEAE. Synonyms: *Picrasma excelsa* Planch., *Simaruba excelsa* DC., *Quassia excelsa* Swartz, *Picraena excelsa* Lindl. **Jamaica quassia.** West Indies.

The use of quassia wood as an insecticide is well known. See the paper by the writers (*60*).

**Aesculus glabra** Willd. AESCULACEAE. **Ohio buckeye.** Eastern United States.

Riley (*71, p. 184*) reports that an alcoholic extract of the fruit and an alcoholic extract and a decoction of the leaves had no effect on the cotton caterpillars tested.

**Aesculus pavia** L. **Red buckeye.** Southeastern United States.

Porcher (*68, p. 91*) says: "Bedsteads made of the horse-chestnut are said not to be infested by bugs."

**Agave americana** L. AMARYLLIDACEAE. **Centuryplant.** Tropical America.

Von Mueller (*91, p. 24*) reports that "The infusion of the leaves can be applied as an insecticide."

**Agave lecheguilla** Torr. **Lechuguilla.** Texas and Mexico.

Cook, Hutchison, and Scales (*17, p. 13*) and Cook and Hutchison (*18, p. 5*) found that infusions of the roots had only a slight effect on fly larvæ.

**Agrostemma githaga** L. CARYOPHYLLACEAE. **Corncockle.** Europe, adventive in the United States.

Cook, Hutchison, and Scales (*17, p. 13*) determined that an infusion had practically no effect on fly larvæ.

**Ailanthus altissima** (Mill.) Swingle. SIMARUBACEAE. Synonym: *Ailanthus glandulosa* Desf. **Ailanthus.** China, cultivated in the United States.

Riley (*71, p. 184*) reports that a decoction and an infusion of the leaves had no effect on cotton caterpillars.

Von Mueller (*91, p. 27*) reports that it checks the spread of the rosebug, which is destructive to the trees.

**Allium sativum** L. LILIACEAE. **Garlic.** Europe.

Howard (*43, p. 59*), quoting Celli and Casagrandi, says that the odor of garlic will kill mosquitoes if the air is saturated.

**Aloe barbadensis** Mill. LILIACEAE. Synonyms: *A. perfoliata vera* L., *A. vulgaris* Lam. Source of **Barbadoes aloes.** India to northwestern Africa, naturalized in West Indies.

Mason reports that powdered Barbadoes aloes was on one occasion found as effective as insect powder (see Kirby, *48, p. 241*).

**Aloe ferox** Mill. **Cape aloe.** South Africa.

Von Mueller (*91, p. 34*) reports that "The bitter sap, used for dressing wounds, keeps off flies very effectively."

**Aloe** spp.

Greshoff (*31, p. 154*) says that the resin from aloes is an insecticide.

Schreiber (*81*) ascertained that a strong decoction of aloes with soap added gave good results against certain lepidopterous larvæ and aphids.

**Amanita muscaria** (L.) Pers. AGARICACEAE. Synonym: *Agaricus muscarius* L. **Fly agaric.** Europe.

Chesnut (*14, p. 13*) reports that "As a fly poison it has been used in Europe for hundreds of years."

**Amanita pantherina** Fr. Java.

Lyons (*53, p. 29*) reports that it is used as a fly poison.

**Ambrosia elatior** L. ASTERACEAE. Synonym: *A. artemisiifolia* L. **Ragweed.** Eastern United States to British Columbia and Mexico.

Riley (*71, p. 184*) says that an alcoholic extract and a decoction had no effect on cotton caterpillars.

**Ambrosia trifida** L. **Great ragweed.** Ontario to Florida and Colorado.

Riley (*71, p. 184*) reports that a decoction, infusion, and an alcoholic extract had no effect on cotton caterpillars.

**Amygdalus persica** L. ROSACEAE. **Peach.** Old World.

Smith (*86, p. 33*) says that the decoctions of peach leaves, of the blossoms of Ailanthus, and of the oxeye daisy had no effect on the rosechafer.

The writers' results are given on page 21.

**Anamirta cocculus** (L.) Wight & Arn. MENISPERMACEAE. Synonyms: *A. paniculata* Colebr., *Menispermum cocculus* L., *Menispermum lacunosum* Lam. Fruit=Cocculus indicus or **fish-berries.** East Indies and Hindustan.

Greshoff (*33, p. 46*) reports that Bacon says that in the Philippines the fruit is used for an antiparasitic ointment, and Lyons (*53, p. 35*) lists it as a parasiticide.

**Angelica** sp. APIACEAE. **Angelica.**

Scott, Abbott, and Dudley (*83, p. 5, 13, 26*) determined that angelica root was ineffective against bedbugs, roaches, and clothes moths, and Abbott (*1, p. 7, 11*) found it of no value against chicken lice and the dog flea.

**Añiliton.**[4] Venezuela.

The writers' results are given on page 21.

**Annona cherimola** Mill. ANNONACEAE. Synonym: *A. tripetala* Ait. **Cherimoya.** Peru.

Greshoff (*31, p. 12*) reports that the seed is used as an insecticide.

**Annona glabra** L. **Pond-apple.** Tropical America.

Maisch (*54*) reports that the powder of the seed is used as an insecticide.

**Annona reticulata** L. **Custard-apple.** Tropical America.

Maisch (*54*) says that the use of this is similar to that just above.

**Annona spinescens** Mart. Brazil.

Greshoff (*31, p. 12*) reports that the seeds, either finely powdered or in the form of a decoction, are used as an insecticide.

Dragendorff (*22*) states that the pulp is used as a fish poison and for the killing of noxious insects.

[4] Several specimens of material received bore only local names, and from such data it was impossible to identify the plants scientifically. These local names are catalogued alphabetically, and it is hoped that their botanic names may be learned subsequently.

**Annona squamosa** L. **Sugar-apple.** Tropical America.

Greshoff (*31, p. 11*), quoting Hartwich, says that the seeds are used against head lice, and Lyons (*53, p. 41*) says that they are used as a parasiticide.

**Anthemis arvensis** L. ASTERACEAE. **Corn camomile.** Europe, naturalized in the United States.

Kalbruner (*47*) says that the flowers were entirely inactive against flies.

Greshoff (*33, p. 157*) reports that the odor drives away mice and insects.

**Anthemis cota** L. Italy.

Passerini (*66, p. 42*) determined that the flower heads killed the dog flea, although very slowly, but had no practical effect on flies and ants.

**Anthemis cotula** L. Synonym: *Maruta cotula* DC. **Mayweed.** Europe, naturalized in the United States.

Garrigues (*25*) reports that a decoction of the leaves is said to destroy all species of insects.

The powdered flower heads (*3*) were very effective against bedbugs, fleas, and flies, but ineffective against grain worms and other caterpillars.

Kalbruner (*47*) says that the flowers were entirely inactive against flies.

**Anthemis nobilis** L. Synonym: *Chamomilla nobilis* Godr. **Common camomile.** Europe, cultivated and adventive in the United States.

Gieseler (*26*) reports that the flower heads have an action on insects similar to that of insect powder.

Kalbruner (*47*) says that they were entirely inactive against flies.

Cook and Hutchison (*18, p. 4*) found them ineffective against fly larvæ.

**Anthemis tinctoria** L. **Yellow camomile.** Europe, Asia.

Kalbruner (*47*) says that the flowers were entirely inactive against flies, and Passerini (*66, p. 42*) found them of no practical use against flies and ants, but they did kill the dog flea slowly.

**Anthemis** sp.

Howard (*44, p. 96*), quoting Cruz of Rio de Janeiro, says that camomile, used as a fumigant in rooms in which yellow-fever patients are confined, is absolutely efficient against mosquitoes (*Aëdes calopus*).

**Arisaema dracontium** (L.) Schott. ARACEAE. Synonym: *Arum dracontium* L. Indian turnip. **Dragonroot.** Canada and eastern United States.

Pammel (*64, p. 103*) says that the corm of the Indian turnip is somewhat acid and is used to kill insects.

**Arisaema japonicum** Blume. Japan.

Greshoff (*33, p. 19*) reports that the roots are used in Japan as an insecticide.

**Arisaema tortuosum** Schott. Himalayan region.

Greshoff (*31, p. 157*) reports that the roots are used as an insecticide.

**Aristolochia cornuta** Mast., **A. brasiliensis** Mart., and **A. elegans** Mast. ARISTOLOCHIACEAE. Brazil.

Greshoff (*31, p. 131*) reports that the insects visiting these three species are killed.

**Artemisia absinthium** L. ASTERACEAE. Synonym: *Absinthium vulgare* Lam. **Common wormwood.** North Africa and Europe; thoroughly established and common in eastern Canada and northern New England.

Von Mueller (*91, p. 55*) says that it is "recommended for cultivation as a preventive of various insect-plagues, even phylloxera."

Schreiber (*81*) and Goriainov (*29*) determined that various dilutions of extracts had only a slight effect on the insects tested.

Cook and Hutchison (*18, p. 4*) found that the powdered leaves had no effect on fly larvæ.

**Artemisia tridentata** Nutt. **Sagebrush.** Western North America.

The writers' results are given on page 21.

**Asclepias curassavica** L. ASCLEPIADACEAE. **Bloodflower.** Tropical America.

Manning (*56*) reports that the Indians of southern Mexico sweep the floors and walls of their huts with this and find that they are not troubled with fleas for some time afterwards, and Bergey (*10*), quoting McDougall, makes similar statements and reports that the odor of this milkweed when thus used has been found to check the spread of fleas in houses.

**Asclepias tuberosa** L. ASCLEPIADACEAE. **Butterflyweed.** Eastern North America.

Cook and Hutchison (*18, p. 4*) found that an infusion of the roots had a considerable effect on fly larvæ, but it was not efficient.

**Asimina** sp. ANNONACEAE. **Papaw.**

Howard (*44, p. 24*) reports that papaw trees have been planted to serve as a mosquito repellent, but they are of no value.

**Aster linosyris** Bernh. and **A. tripolium** L. ASTERACEAE. Europe.

Passerini (*66*) found the heads of these species inactive against flies.

**Atropa belladonna** L. SOLANACEAE. **Belladonna.** Southern Europe and Central Asia.

Riley (*71, p. 184*) found that an alcoholic extract and a decoction of the leaves had no effect on cotton caterpillars.

The writers' results are given on page 21.

**Azolla** sp. SALVINIACEAE.

Howard (*44, p. 25, 27*) and Smith (*87, p. 437*) report that certain water plants, such as Azolla, Lemna, and "Phu-lo," have been grown in water where mosquitoes breed, and it has been ascertained that these check the breeding of the mosquitoes to a limited degree by preventing the larvæ from getting air.

**Balbec.** (See footnote on page 26.)

The writers' results are given on page 21.

**Baptisia tinctoria** (L.) R. Br. FABACEAE. Synonym: *Sophora tinctoria* L. **Yellow wild-indigo.** Eastern United States.

Williams (*94, p. 916*) reports that the plants, when placed in the harness, keep flies from the horses, and Porcher (*68, p. 202*) makes similar statements about its use.

Riley (*71, p. 184*) says that an alcoholic extract and a decoction had no effect on cotton caterpillars.

**Berberis aquifolium** Pursh. BERBERIDACEAE. **Oregon hollygrape.** Synonym: *Mahonia aquifolium* Nutt. Western North America.

Cook and Hutchison (*18, p. 4*) ascertained that an infusion of the roots had a considerable effect on fly larvæ, but it was inefficient.

**Bocconia cordata** Willd. PAPAVERACEAE. Synonym: *Macleaya cordata* R. Br. **Pink plumepoppy.** Japan.

Greshoff (*31, p. 18*) reports that the decoction is used in Japan as an insecticide.

**Bryonia alba** L. CUCURBITACEAE. **White bryony.** Old World.

Gomilevsky (*28*) reports that the root and other parts can be used against aphids.

**Caladium bicolor** (Ait.) Vent. ARACEAE. South America.

Greshoff (*31, p. 158*) reports that the powdered leaves are used as an insecticide.

**Callilepis laureola** DC. ASTERACEAE. South Africa.

Greshoff (*33, p. 155*) reports that the powdered roots are used as an insecticide in Natal.

**Cannabis sativa** L. MORACEAE. **Common hemp.** Asia, cultivated in the United States.

Riley and Howard (*72, p. 223*) report that hemp combings or leaves, scattered among bags and heaps of grain in India, are effective against weevils.

Von Mueller (*91, p. 97*) says: "The hemp-plant serves as a protection against insects on cultivated fields, if sown along their boundaries."

**Capsicum annuum** L. SOLANACEAE. **Common redpepper.** South America, now widely cultivated.

Scott, Abbott, and Dudley (*83, p. 5, 14*) found that redpepper was ineffective against bedbugs and roaches.

Abbott (*1, p. 12*) found redpepper of no value against the dog flea.

**Carapa guianensis** Aubl. MELIACEAE. Synonym: *Xylocarpus carapa* Spreng. **Andiroba** or **carapa tree.** Guiana.

Greshoff (*33, p. 84*), quoting Peckolt, reports that the decoction is used as an insecticide.

**Caryophyllus aromaticus** L. MYRTACEAE. Synonym: *Eugenia aromatica* Baill. **Clovetree.** Tropical regions.

Scott, Abbott, and Dudley (*83, p. 13, 34*) found powdered cloves ineffective against roaches, but efficient against the larvæ of carpet beetles, and Abbott (*1, p. 7, 11*) found them efficient against chicken lice and the dog flea, although he does not recommend them on account of their high cost.

**Cassia occidentalis** L. CAESALPINIACEAE. **Coffee senna.** Widely diffused in tropical countries.

Riley (*71, p. 186*) reports that an alcoholic extract and a decoction had a slight effect on cotton caterpillars.

Scott, Abbott, and Dudley (*83, p. 13*) found *Cassia* (species not given) ineffective against roaches.

**Cassia stipulacea** Ait. Chili.

Greshoff (*31, p. 67*) reports that the leaves are used as an insecticide.

**Catalpa bignonioides** Walt. BIGNONIACEAE. **Catalpa.**

The writers' results are given on page 21.

**Causia** and **Cebolleja.** (See footnote on page 26.)

Herrera (*40, p. 21*) obtained no practical results by using both of these against the winged forms of fruit maggots.

**Ceratotheca integribracteata** Engl. PEDALIACEAE. Tropical Africa.

Greshoff (*33, p. 145*) says that the decoction is used in West Africa as an insecticide.

**Cereus** sp. CACTACEAE. **Cactus.**

Howard (*44, p. 74*) says that cactus leaves, made into a sticky paste and spread over the surface of the water, kill the larvæ of mosquitoes by asphyxiation.

**Charcoal** (kind not stated).

Scott, Abbott, and Dudley (*83, p. 13, 26*) found charcoal ineffective as a dust against roaches and ineffective as a fumigant against clothes moths.

**Chelidonium majus** L. PAPAVERACEAE. **Swallow-wort.**

Goriainov (*29*) determined that a decoction killed 4 per cent of the larvæ of *Malacosoma neustria* and 44 per cent of the *Vanessa urticae* tested.

**Chenopodium ambrosioides** L. CHENOPODIACEAE. Synonyms: *C. anthelminticum* L., *C. ambrosioides anthelminticum* A. Gray. **American wormseed.** Tropical America, naturalized in the United States.

Riley (*71, p. 186*) reports that an infusion and an alcoholic extract from the blossoms and green fruit had no effect on cotton caterpillars.

The writers' results are given on page 22.

**Chilocoan** or **Chilcoagua.** (See footnote on page 26.)

Herrera (*40, p. 21*) obtained no practical results by using this plant against the winged forms of fruit maggots.

**Chrosperma muscaetoxicum** (Walt.) Kuntze. LILIACEAE. Synonyms: *Amianthium muscaetoxicum* A. Gray, *Melanthium muscaetoxicum* Walt., *Zygadenus muscitoxicum* Regel. *Helonias erythrosperma* Michx. **Crow poison.** Eastern United States.

Elliott (*23*) says: "This plant is a narcotic poison, and is employed in some families for destroying the house-fly. The bulbs are triturated and mixed with molasses or honey, and the preparation is spread upon plates and placed in parts of the house most infested. The flies are soon attracted, and the poison takes effect while they are sipping it. They are perceived to stand unsteadily, totter, and fall supine. The flies, unless swept in a fire or otherwise destroyed, revive in the course of 24 hours."

Lyons (*53, p. 117*) says that the bulbs are used as an insecticide.

The writers' results are given on page 5.

**Chrysanthemum achilleae** L. ASTERACEAE. Synonym: *Pyrethrum achilleae* DC. Italy.

Passerini (*66*) found that the opened flower heads had some effect on flies, fleas, and ants; they were not much inferior to those of *P. cinerariaefolium.*

**Chrysanthemum caucasicum** (Willd.) Pers. Caucasian region.

According to Bishop (*11*), Persian insect powder is made from this species, but more reliable authors deny this statement.

**Chrysanthemum cinerariaefolium** (Trev.) Vis. Synonym: *Pyrethrum cinerariaefolium* Trev. **Dalmatian insect flowers.** Dalmatia. Cultivated in Japan and California.

The powdered flower heads of this plant constitute the well-known Dalmatian insect powder, and the Insecticide and Fungicide Board of the United States Department of Agriculture (*57, p. 1*) recognizes it as one of the three species from which genuine insect powder is made.

Passerini (*66*) tested the powdered heads and leaves of this plant and 14 other species belonging to Asteraceae and concluded by saying that not one of the 14 species has properties so powerful or so swift in its action against the house fly (*Musca domestica* L.), or the dog flea (*Ctenocephalus canis* Curt.) or against ants (*Cremastogaster scutellaris* Oliv.), as has this species. He states that when all parts of the plant are reduced to powder, they are active; the leaves, stems, and roots in a somewhat less degree than the flower heads. Scott, Abbott, and Dudley (*83, p. 7, 10*) determined that powdered pyrethrum stems had little or no practical value against bedbugs and cockroaches. Scott and Abbott (*57, p. 81*) ascertained that the stems and bracts (small leaves) were ineffective against roaches. Abbott (*1, p. 8, 14*) found pyrethrum stems to have no value against chicken lice and the dog flea. Mr. Abbott, Entomologist, Enforcement of the U. S. Insecticide Act, authorizes the writers to use the following statement, taken from his unpublished notes: "Pyrethrum stems are inefficient against 6 species of ants, 9 species of aphids, bedbugs, 3 species of chicken lice, chicken mites, clothes moth larvæ,

dog fleas, house flies, mosquitoes, *Orthezia insignis*, red spiders, and roaches."

As early as 1879 and 1880 Riley's (*71, p. 174-180*) assistants used infusions, decoctions, and alcoholic extracts of pyrethrum against the cotton caterpillars and a few other insects. They report little or sometimes no success with the extracts thus obtained. Cory (*19*), after making several tests with a commercial alcoholic extract, prepared in the form of a heavy liquid soap, reports that it is a promising insecticide against aphids, but Hamilton (*37*) used some of it against the boxwood leaf midge and had no success. Juillet, Calavielle, and Ancelin (*46*) extracted pyrethrum with ether, alcohol, and carbon tetrachlorid, and then incorporated these extracts into soap solution. They believe that these soapy extracts are superior to all other insecticides used in viticulture against Cochylis and Eudemis.

The writers' results are given on pages 6, 10 to 21.

**Chrysanthemum coccineum** Willd. Synonyms: *C. roseum* Adam, *Pyrethrum carneum* Bieb. **Persian insect flowers.** Persia to Caucasus Mountains.

Von Mueller (*91, p. 121*) claims that this species yields the Persian insect powder, and this is one of the three species, recognized by the Insecticide and Fungicide Board of the United States Department of Agriculture (*57, p. 1*), from which genuine insect powder is made.

**Chrysanthemum coronarium** L. **Crown daisy.** Mediterranean region.

Kalbruner (*47*) says that the flowers of this were entirely inactive against flies.

**Chrysanthemum corymbosum** L. Synonym: *Pyrethrum corymbosum* Scop. Europe, Asia, Africa.

Kalbruner (*47*) says that the flowers were feebly benumbing to flies.

Böhmer (*12*) states that a powder made from the opened and unopened flower heads, dried in the sun, was slightly less active than insect powder against ants and flies.

Passerini (*66*) did not find the opened flower heads of much value against flies, the dog flea, and ants.

**Chrysanthemum frutescens** L. **Marguerite.** Canary Islands, cultivated in gardens.

Landerer (*52*) claims that the flowers of this can ordinarily be substituted for genuine insect powder.

**Chrysanthemum indicum** L. **Mother chrysanthemum.** China and Japan.

Passerini (*66*) found the open and closed flower heads and the leaves of this species entirely inactive against the insects tested.

**Chrysanthemum leucanthemum** L. Synonym: *Leucanthemum vulgare* Lam. **Oxeye daisy.** Europe and Asia, naturalized in eastern United States.

Kalbruner (*47*) found the flowers entirely inactive against flies.

Riley (*71, p. 180*) found the powder, water extract, and alcoholic extract from the flower heads had no effect on cotton caterpillars.

Cook, Hutchison, and Scales (*17, p. 21*) found that this species had no effect on fly larvæ.

The writers' results are given on page 22.

**Chrysanthemum marschallii** Aschers. Synonym: *Pyrethrum roseum* Bieb. **Caucasian insect flowers.** Caucasian region.

This is one of the three species, recognized by the Insecticide and Fungicide Board of the United States Department of Agriculture (*57, p. 1*), from which genuine insect powder is made.

**Chrysanthemum myconis** L. Mediterranean region.

Passerini (*66*) says that the flower heads killed dog fleas, although very slowly.

**Chrysanthemum parthenium** (L.) Pers. Synonyms: *Matricaria parthenium* L., *Pyrethrum parthenium* J. E. Smith. **Feverfew.** Europe, adventitious in the United States.

Glover (*34, p. 133*) says that when the flowers are dried and perfectly fresh they have an effect on roaches similar to that of insect powder.

Kalbruner (*47*) found the flowers to have a benumbing effect on flies, acting within one or two hours.

Passerini (*66*) says that the flower heads of *Pyrethrum parthenium* (L.) Bernh. were not effective against the insects tested.

**Chrysanthemum segetum** L. Synonym: *Pyrethrum segetum* Moench. **Corn-marigold.** Europe.

Landerer (*51*) says that this is used in Greece and is as effective as Persian insect powder, particularly when it is used in fumigating.

**Cimicifuga racemosa** (L.) Nutt. RANUNCULACEAE. Synonym: *C. serpentaria* Pursh. **Cohosh bugbane.** Eastern United States.

Sayre (*78*) says that the powdered roots, used as a dust, had no effect on crickets; and also used in the form of a fumigant, an alcoholic extract and an aqueous extract, they had little or no effect on the insects.

**Cinchona succirubra** Pavon. RUBIACEAE. Peru.

Cook and Hutchison (*18, p. 4*) ascertained that the powdered bark gave a fairly high percentage of mortality against fly larvæ, but it did not seem entirely efficient.

**Citrullus colocynthis** (L.) Schrad. CUCURBITACEAE. Synonyms: *Cucumis colocynthis* L., *Colocynthis vulgaris* Schrad. **Colocynth.** Asia, Africa, and southern Europe.

Greshoff (*31, p. 80*) reports that a decoction of colocynth serves as an insecticide.

Scott, Abbott, and Dudley (*83, p. 5, 13, 26*) found the pulp ineffective against bedbugs, roaches, and clothes moths, and Abbott (*1, p. 7, 11*) found it of no value against chicken lice and the dog flea.

**Claviceps purpurea** (Fries) Tulasne.

Gomilevsky (*28*) reports that a water extract killed aphids, Psylla, thrips, and probably also other sucking insects and those unprotected by hairs.

**Cleistanthus collinus** (Roxb.) Benth. & Hook. EUPHORBIACEAE. East Indies.

Greshoff (*31, p. 141*), quoting Biscoe in Indian Forester, says: "The bark must contain some poison property, for not only do white ants leave it severely alone, but it is used here for poisoning fish. The inner bark placed on sores of sheep and goats is efficacious in healing them and in destroying maggots."

**Clibadium surinamense** L. ASTERACEAE. Tropical America.

The writers' results are given on page 22.

**Conium maculatum** L. APIACEAE. **Poison-hemlock.** Europe.

Gomilevsky (*28*) reports that the infusion of flowers, leaves, and stems is effective against various insects.

Cook and Hutchison (*18, p. 4*) found the powdered fruit ineffective against fly larvæ.

**Cracca villosa purpurea** (L.) Kuntze. FABACEAE. Synonyms: *C. piscatoria* Lyons, *Galega purpurea* L., *G. piscatoria* Ait., *Tephrosia piscatoria* Pers., *T. purpurea* Pers. **Pacific fish-poison.** Old World.

Lyons (*53, p. 145*) says: "Fish poison, Auhuhu, Hola (Hawaii). Tropical regions generally. Plant has narcotic properties; used medicinally in India and to stupefy fish in islands of Pacific."

The writers' results are given on page 22.

**Cracca** sp. FABACEAE. Synonym: Tephrosia. Warm and tropical regions.

Roark (*75, p. 35*) says: "U. S. Patent 1242954. A compound for use as an insecticide and sheep dip is formed from sulphur soap and comminuted Tephrosia (Cracca) plants, seeds, or leaves. U. S. 1242955 specifies, for the same purpose, a benzine extract of Tephrosia (Cracca) 0.5 to 1, soap 4, and dilute alcohol 15 parts."

**Croton eluteria** (L.) Swartz. EUPHORBIACEAE. **Cascarilla.** Bahamas.

Howard (*44, p. 30*) reports that cascarilla bark, used as a fumigant in Bermuda, is a mosquito repellent.

**Croton flavens** L. West Indies and northern South America.

Thoms (*90*) says that this is reported to be an insecticide in Venezuela, but he found it to have no effect on roaches, flies or gnats.

**Croton texensis** (Klotzsch) Muell. Arg., **C. glandulosus** L., **C. capitatus** Michx., and **C. monanthogynus** Michx. **Crotonweed.**

Riley (*71, p. 186*) reports that decoctions from the leaves and blossoms of these species had no effect on cotton caterpillars.

**"Cube"** [5] (pronounced koo'-bay), **cuyi** or **cume.** Local names in Peru. Peru.

The writers' results are given on pages 6, 10 to 20.

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[5] The name "cube" is applied, in all tropical America, to several plants belonging to distinct genera, which are used as fish poisons. Among them are species of Jacquinia, and several plants belonging to the family Sapindaceae. The identity of the "cube" here referred to is not certain. It will be necessary to receive botanical specimens of the plant before it can be determined.—W. E. Safford.

**Cytisus scoparius** (L.) Link. FABACEAE. **Scotch broom.** Europe.

An infusion (*8*), made from fresh crushed broom tops, is recommended to kill the larvæ of cabbage butterflies. In France it has also been found very effective for removing Cochylis larvæ from vines and various caterpillars from apple trees.

The writers' results are given on page 22.

**Dasystoma flava** (L.) Wood. SCROPHULARIACEAE. Synonym: *Gerardia flava* L.

Porcher (*68, p. 509*) says: "This plant, it is said, will prevent the attacks of yellow and other flies upon horses."

**Datura stramonium** L. SOLANACEAE. **Jimsonweed.** Jamestown weed. A cosmopolitan weed.

Riley (*71, p. 184*) reports that neither the alcoholic extract from the dried seed or leaves, nor a decoction from the leaves, was effective against cotton caterpillars.

Fernald (*24, p. 10*) determined that a strong infusion of the leaves had no effect on potato beetles, rose beetles, or the larvæ of *Vanessa milberti*.

McClintock, Hamilton, and Lowe (*58, p. 233*) ascertained that the leaves, used as a fumigant, were effective against bedbugs, roaches, flies, clothes moths, and mosquitoes, but they were not efficient.

Sprenger (*88*) recommends the decoction as an insecticide.

Cook, Hutchison, and Scales (*17, p. 14*) determined that a sulphuric-acid extract of the leaves was of no value against fly larvæ.

The writers' results are given on page 22.

**Delphinium ajacis** L. RANUNCULACEAE. **Rocket larkspur.** Southern Europe, and cultivated in gardens.

Greshoff (*31, p. 8*) lists it as an insecticide.

Williams (*95*), after testing against bedbugs the extracts, derived from the seeds by using various solvents, decided that the insecticidal value of the seeds is due mostly to the oil present in them, while the alkaloid in them plays an insignificant part.

**Delphinium bicolor** Nutt. **Low larkspur.** Western North America.

The writers' results are given on page 22.

**Delphinium brunonianum** Royle. **Musk larkspur.** Himalayan region.

Greshoff (*31, p. 7*) reports that the juice is used to destroy ticks on animals.

**Delphinium caeruleum** Jacquem. Himalayan region.

Greshoff (*31, p. 7*) reports that the roots are used to kill maggots.

**Delphinium consolida** L. **Field larkspur.** Central Europe, cultivated in gardens and adventive in the United States.

Williams (*94, p. 875*) says: "A tincture, prepared by infusing an ounce of the seeds in a pint of alcohol * * * kills lice on the human head."

Porcher (*68, p. 18*) reports that the tincture of the plant is destructive to insects on children's heads.

Riley (*71, p. 114*), quoting a correspondent, says: "I have found the common larkspur an effective poison on insects."

**Delphinium staphisagria** L. **Lousewort.** Mediterranean region.

Hare, Caspari, and Rusby (*38*) say that this species is employed in medicine solely as a local application for the destruction of lice and the itch-mite.

**Delphinium** sp. **Larkspur.**

Osborn (*63, p. 175*) reports that Tenny recommends a decoction of the seed of common larkspur as an insecticide against the short-nosed ox louse.

Cook, Hutchison, and Scales (*17, p. 14*) found that a sulphuric-acid extract of the ground seed had a considerable effect on fly larvæ, and Cook and Hutchison (*18, p. 4*) obtained similar results by using an infusion of the ground seed, but none of these were efficient.

**Derris elliptica** (Wall.) Benth. FABACEAE. Malayan or **East Indian fish-poison.** Aker. Tuba. Malayan region.

See "Derris as an insecticide," by McIndoo, Sievers, and Abbott (*61*).

The results obtained during this investigation by the writers are given on pages 7, 10 to 20.

**Derris uliginosa** Benth. **Eastern fish-poison.** Old World Tropics.

Perredes (*67*) says: "In India it is known to act as a poison upon worms and the larvæ of insects which trouble the cultivators, whence the Marathi name Kirtána, or 'worm-creeper.'"

Howard (*44, p. 78*) reports that a decoction placed in water at the Wellcome Research Laboratories at Khartoum had considerable potency against mosquito larvæ, but also killed the fish present in the water.

**Diospyros malacapai** A. DC. EBENACEAE. Philippine Islands.

Greshoff (*31, p. 103*) reports the wood as an insecticide.

**Echinops echinatus** Roxb. ASTERACEAE. East Indies.

Greshoff (*33, p. 160*), quoting Burkill, says: "The roots are pounded and applied to the hair to destroy lice, also the powdered roots applied to wounds in cattle to destroy maggots."

**Eucalyptus globulus** Labill. MYRTACEAE. **Blue gum.** Victoria and Tasmania.

Von Mueller (*91, p. 192*) says: "Warren reports from San Francisco that branchlets of eucalyptus will drive mosquitoes and other insects out of rooms."

**Eucalyptus** spp.

Riley and Howard (*73, p. 268*) quote a correspondent who says that a few twigs or leaves laid on the pillow at night will secure perfect immunity against mosquitoes.

Sanders (*77, p. 344*) says that when a grove of eucalyptus is planted near the house mosquitoes never give annoyance in the house, but Howard (*43, p. 62*, and *44, p. 22*) states that eucalyptus trees are probably of no value as mosquito repellents.

Howard (*43, p. 59*), quoting Celli and Casagrandi, says that the fumes from the fresh leaves will kill mosquitoes if the air is saturated.

Scott, Abbott, and Dudley (*83*, *p. 5*, *13*, *26*) found the leaves ineffective against bedbugs, roaches, and the larvæ of clothes moths, and Abbott (*1*, *p. 7*, *11*) found them ineffective against chicken lice and the dog flea.

**Euonymus americanus** L. CELASTRACEAE. **Brook euonymus.** Eastern United States.

Porcher (*68*, *p. 154*) says that the seeds are used in some places to destroy vermin in the hair.

**Euonymus atropurpureus** Jacq. **Wahoo.** Eastern United States.

Porcher (*68*, *p. 154*) says that this possesses properties similar to that above.

**Euonymus europaeus** L. **European burningbush.** Europe, adventitious in the United States.

Lyons (*53*, *p. 188*) lists this as an insecticide.

**Eupatorium capillifolium** (Lam.) Small. ASTERACEAE. **Dog-fennel.** Southeastern United States.

Roark (*75*, *p. 92*) states that Porcher reports this by saying: "It is used to keep off insects and bugs by strewing on the floors of cellars and dairies."

**Eupatorium perfoliatum** L. Synonym: *E. connatum* Michx. **Boneset.** Eastern United States.

Riley (*71*, *p. 184*) reports that the powdered leaves seemed obnoxious to cotton caterpillars, but an infusion from the leaves had no effect on them.

**Eupatorium** sp.

Greshoff (*31*, *p. 93*) lists this as an insecticide.

**Euphorbia cotinoides** Miquel. EUPHORBIACEAE. Guiana.

The writers' results are given on page 22.

**Euphorbia marginata** Pursh. Synonym: *Dichrophyllum marginatum* Klotzsch & Garcke. **Snow-on-the-mountain.** Minnesota to Texas.

Riley (*71*, *p. 186*) reports that a decoction was ineffective against cotton caterpillars.

**Euphorbia** spp.

Chesnut (*13*, *p. 407*) says: "The juice of *E. marginata* and *E. bicolor* is used to some extent in Texas to brand cattle, it being held to be superior to a red-hot iron for that purpose, because screw worms will not infect the fresh scar and the spot heals more readily."

Sprenger (*88*) recommends *E. biglandulosa* and *E. dendroides* as insecticides in the form of decoctions.

Goriainov (*29*) determined that a decoction of spurge (*Euphorbia* sp.) killed only 38 per cent of the *Malacosoma neustria* tested.

**Fluggea leucopyrus** Willd. EUPHORBIACEAE. East Indies.

Greshoff (*32*), quoting Dymock, says that the leaves are used as an insecticide.

**Furcraea cubensis** Vent. AMARYLLIDACEAE. Tropical America.

The writers' results are given on page 22.

**Galinsoga parviflora** Cav. ASTERACEAE. **Galinsoga.** South America, introduced in the United States.

The writers' results are given on page 22.

**Gouania lupuloides** (L.) Urban (synonym *G. domingensis* L.) and **G. polygama** (Jacq.) Urban (synonym *G. tomentosa* Jacq.). RHAMNACEAE. Tropical America.

Greshoff (*33, p. 107*) reports that both of these are used as insecticides.

**Gymnocladus dioica** (L.) Koch. CAESALPINIACEAE. Synonyms: *G. canadensis* Lam., *Guilandina dioica* L. **Kentucky coffeetree.** Eastern United States.

Von Mueller (*91, p. 248*) says: "Insects preying on the foliage of this tree are poisoned by it."

Chesnut (*14, p. 28*) reports that the leaves and fruit pulp have been used, when rubbed up with milk, to poison flies.

Pammel (*64, p. 117*) says: "In the South the leaves are used as fly poison."

The writers' results are given on page 22.

**Haplophyton cimicidum** A. DC. APOCYNACEAE. **"Cucaracha"** herb of Mexico. Arizona to Guatemala and Cuba.

Greshoff (*31, p. 107*) lists this as an insecticide.

According to the Experiment Station Record (*7*), "The cucaracha herb is reported as being an effective remedy for destroying lice and fleas on dogs, cockroaches, mosquitoes, and other insects. The pest plant costs 1 ct. [centavo] per kilo and may be used in infusion."

Herrera (*40, p. 21, 69–71, 188*) states that he had considerable success in poisoning Culex, Anopheles, various species of Instrypetas, and other Diptera by using the juice and infusion of the leaves, the juice and infusion of the entire plants, the maceration of the bark, and the concentrated alcoholic extract. He also states that an attempt has been made to cultivate this plant for the purpose of obtaining insecticidal material. The same author (*41, p. 247 et seq.*) summarizes the results of his earlier paper and furthermore describes the action of this plant on insects, names other plants similar to the herb of cucaracha, and briefly discusses the composition of the toxic principle found in these plants.

**Hedeoma pulegioides** (L.) Pers. MENTHACEAE. Synonym: *Cunila pulegioides* L. **American pennyroyal.** Eastern United States.

Riley (*71, p. 185*) states that the infusion, decoction, and alcoholic extract were ineffective against cotton caterpillars.

Lyons (*53, p. 223*) reports that it is used to drive away mosquitoes.

**Helenium autumnale** L. (**Sneezeweed**) and **H. tenuifolium** Nutt. (**Bitterweed**). ASTERACEAE. Eastern United States.

Riley (*71, p. 184*) reported that these plants rendered cotton plants so obnoxious to cotton caterpillars that the insects would not feed upon them, but the caterpillars were not killed. The decoction, infusion, and alcoholic extract were without effect, as were likewise the dried and powdered flower heads.

The writers' results, obtained by using the latter species, are given on page 22.

**Heliotropium indicum** L. BORRAGINACEAE. **India heliotrope.** Tropical regions.

Riley (*71, p. 186*) reports that a decoction had no effect on cotton caterpillars.

**Helleborus niger** L. RANUNCULACEAE. **Black hellebore.** Europe.

Cook and Hutchison (*18, p. 4*) found the powdered roots of *H. niger* inefficient against fly larvæ.

**Hicoria glabra** (Mill.) Britton. JUGLANDACEAE. Synonyms: *Juglans glabra* Mill., *Carya porcina* Nutt., *C. glabra* Spach. **Pignut.** Eastern United States.

Williams (*94, p. 920*) says: "An infusion of the leaves in water and washing a horse with them in fly time prevents the annoyance of those insects."

**Hiptage madablota** Gaertn. MALPIGHIACEAE. Tropical Asia.

Greshoff (*33, p. 84*) lists this as an insecticide.

**Honduras fish-poison.** (See footnote on page 26.)

The writers' results are given on page 22.

**Hura crepitans** L. EUPHORBIACEAE. **Sandboxtree.** Tropical America.

The writers' results are given on page 8.

**Hyndocarpus anthelminthica** Pierre. BIXACEAE. Tropical Asia.

Greshoff (*33, p. 112*) reports that the seeds are used as an insecticide.

**Hyoscyamus niger** L. SOLANACEAE. **Henbane.** Southern Europe, sparingly naturalized in the United States.

Sprenger (*88*) recommends decoctions of three species (*niger*, *albus*, and *major*) as insecticides.

Schreiber (*81*) found a strong decoction of henbane effective against aphids only.

Goriainov (*29*) found a decoction of henbane inefficient against two species of caterpillars and efficient against one species.

**Ichthyomethia piscipula** (L.) Hitchc. FABACEAE. Synonyms: *Piscidia erythrina* L., *P. piscipula* Sarg. **Jamaica fish-poison.** Jamaica dogwood. Jamaica.

Cook and Hutchison (*18, p. 4*) found that the powdered bark had considerable effect against fly larvæ.

**Indigofera tinctoria** L. FABACEAE. Synonym: *I. indica* Lam. **True indigo.** Tropical countries.

Porcher (*68, p. 205*) says: "In Jamaica, it is employed to destroy vermin."

Greshoff (*31, p. 52*) reports that the seeds yield a tincture which is used to destroy lice.

**Inula conyza** DC. ASTERACEAE. Synonyms: *I. squarrosa* Bernh., *Conyza squarrosa* L. **Cinnamon-root.** Europe.

Lyons (*53, p. 246*) lists it as an insecticide.

**Inula viscosa** (L.) Ait. Synonym: *Erigeron viscosus* L. Mediterranean region.

Landerer (*49*) reports that when this plant is used as a fumigant in Greece, it does not narcotize the insects but drives them away, and the same author (*50*) says that it is one of the most common plants of Greece. The fumes of the burning plant have the same stupefying effect on mosquitoes as those of Caucasian insect powder.

Passerini (*66*) found the flower heads inactive against flies.

**Iris florentina** L. IRIDACEAE. **Orris-root.**

Abbott (*1, p. 7, 12*) found orris root of no value against chicken lice and the dog flea.

**Jatropha macrorhiza** Benth. EUPHORBIACEAE. Mexico and southwestern United States.

The writers' results are given on page 22.

**Juglans nigra** L. JUGLANDACEAE. **Black walnut.** Ontario and eastern United States.

Porcher (*68, p. 362*) says: "Walnut leaves soaked in water for some hours, then boiled and applied to the skins of horses and other animals, will prevent their being bitten or worried by flies."

Riley (*71, p. 186*) reports that a decoction and an alcoholic extract had no effect on cotton caterpillars, but the insects avoided the sprayed leaves whenever possible.

Montillot (*62, p. 271*) reports that a decoction from walnut leaves, rubbed into the hair of domestic animals, protects these animals from house flies.

André (*2, p. 84*) reports that a decoction of walnut leaves poured on the woolly aphis and in the soil about the roots of orchard trees gives good results.

Guénaux (*35, p. 510*) reports that the infusion from walnut leaves is used to kill plant-lice and certain caterpillars.

**Juniperus sabina** L. PINACEAE. Synonym: *Sabina officinalis* Garcke. **Savin.** Old World.

Greshoff (*31, p. 161*) reports that a decoction of the tops serves as an insecticide.

**Juniperus virginiana** L. PINACEAE. **Redcedar.** Eastern United States.

Porcher (*68, p. 589*) says: "Cedar boxes are not infested by insects, moths, etc., and are used for storing away woolens. The leaves also prevent the attacks of insects when sprayed over cloth."

Scott, Abbott, and Dudley (*83, p. 28*) say: "A red-cedar chest readily killed all adult clothes moths and showed considerable killing effect upon young larvæ."

Back and Rabak (*9*) assert that cedar chests exert no noticeable effect upon the adult clothes moths, but they do kill the young larvæ. These writers indicate that the aroma from a volatile oil contained in the wood is the insecticidal principle.

**Justicia adhatoda** L. ACANTHACEAE. Synonym: *Adhatoda vasica* Nees. **Malabar-nut.** India.

Rusby (*76*) reports that it is fatal to flies, fleas, mosquitoes, and the pupæ of aquatic insects.

**Kalmia angustifolia** L. ERICACEAE. Sheep laurel. **Lambkill.** Eastern North America.

Cook and Hutchison (*18, p. 4*) found that the dried leaves had no effect on fly larvæ.

The writers' results are given on page 22.

**Karwinskia humboldtiana** Zucc. RHAMNACEAE. **Margarita.** Mexico.

The writers' results are given on page 22.

**Lavandula spica** L. MENTHACEAE. Synonym: *L. angustifolia* Mill. **Lavender.** Mediterranean region.

Scott, Abbott, and Dudley (*83, p. 28*) determined that lavender flowers were ineffective while the oil of lavender was effective in protecting flannel from clothes-moth infestation.

**Ledum palustre** L. ERICACEAE. **Crystal-tea.** Northern Europe.

It is reported from Austria (*4*) that this plant kills lice, bedbugs, fleas, moths, and other insects. It is most active when green and in blossom, but the dried material is also effective.

Lyons (*53, p. 266*) reports that the leaves and twigs of *L. palustre* L. are used as an insecticide.

**Ledum groenlandicum** Oeder. Synonym: *L. latifolium* Ait. **True Labrador-tea.** Northern North America.

Williams (*44, p. 916*) says that it is reported to kill lice, insects, etc.

**Leontodon tuberosus** L. ASTERACEAE. Synonym: *Thrincia tuberosa* DC. Old World.

Passerini (*66*) states that the opened flowers and roots were inactive against flies and the dog flea.

**Linaria vulgaris** Hill. SCROPHULARIACEAE. Synonyms: *L. linaria* Karst., *Antirrhinum linaria* L. **Common toadflax.** Europe, naturalized in the United States.

Williams (*94, p. 917*) says: "The expressed juice mixed in milk is a poison to flies, and the smell of the flower also kills them."

**Lonchocarpus** sp. FABACEAE. **Lancepod.**

The writers' results are given on page 23.

**Lycium halimifolium** Mill. SOLANACEAE. **Common matrimony-vine.** Europe, escaped from cultivation in the United States.

The writers' results are given on page 23.

**Lycoperdon bovista** L. LYCOPERDACEAE. Synonyms: *L. giganteum* Batsch., *L. caelatum* Fries, *Bovista giganteum* Nees. **Giant puffball.**

Greshoff (*31, p. 167*) says that it is "Used in its mature condition as a styptic and for stupefying bees."

Gomilevsky (*28*) reports that the spores may be used in the same way as flowers of sulphur. The insects covered with this powder either perish from its mechanical effects or are poisoned by it.

**Lycopersicum esculentum** Mill. SOLANACEAE. Synonyms: *L. lycopersicum* Karst., *Solanum lycopersicum* L. **Tomato.** South America, cultivated everywhere.

Von Mueller (*91, p. 509*) says: "Tomato foliage may be placed round fruit trees, like the equally poisonous potato leaves, to prevent the access of insects, and an infusion of the herb serves also as an insecticide for syringing, as first adopted by Mr. Sircy."

Makaida (*55*) claims to have determined in 1914 that tomatoes, planted near cucumbers, melons, and watermelons, protect these plants against aphids.

Schreiber (*80*) and Vostrikov (*92*) recommend the growing of tomatoes near cabbage beds to drive away cabbage butterflies, and they suggest the use of tomato extracts to control the cabbage caterpillars. Schreiber (*79*) suggests the use of a decoction of tomatoes against the pests of raspberries and dewberries.

Schreiber (*81*) found a concentrated extract of tomatoes very effective against aphids and various other market-garden pests, but Goriainov (*29*), also testing the decoctions of various plants against insects in Russia, carried on his experiments at the Entomological Bureau of Riazan and determined that a decoction of tomatoes gave only insignificant results against *Malacosoma neustria*.

Crouzel (*20*) says: "It is stated that an Italian vine grower, having planted tomatoes between the rows of vines in a vineyard badly infested with Phylloxera, was gratified to note fresh, healthy shoots break forth from the withered stocks, while numbers of dead Phylloxera insects were found around the roots of the tomato plants."

The writers' results are given on page 8.

**Lycopodium complanatum** L. LYCOPODIACEAE. **Groundcedar.** Europe, Asia, and North America.

Williams (*94, p. 924*) reports that the decoction kills lice.

**Lycopodium selago** L. **Fir clubmoss.** Northern hemisphere.

Greshoff (*31, p. 165*) lists it as an insecticide.

**Lysimachia nummularia** L. PRIMULACEAE. **Moneywort.** Europe, naturalized in the United States.

Porcher (*68, p. 509*) reports that the leaves and flowers, steeped in oil, have the power of destroying insects and worms which infest granaries.

**Madhuca** sp. SAPOTACEAE. Synonyms: Bassia, Illipe. East Indies.

The writers' results are given on page 23.

**Marrubium vulgare** L. MENTHACEAE. **Common hoarhound.** Europe and Asia, naturalized in the United States.

Riley (*71, p. 185*) reports that the decoction and alcoholic extract had no effect on cotton caterpillars.

**Matricaria chamomilla** L. ASTERACEAE. Synonyms: *Chrysanthemum chamomilla* Bernh., *Chamomilla vulgaris* S. F. Gray, *Chamomilla officinalis* Koch. **German false-camomile.** Europe and Asia, naturalized in the United States.

Schenck (*82*) reports that the flower heads of the common camomile have an action similar to that of genuine Persian insect powder.

Gieseler (*26*) says that heads of this plant exert an effect on insects similar to that exerted by pyrethrum.

Glover (*34, p. 133*) reports that camomile flowers, if pulverized when dried and perfectly fresh, have an effect on the oriental cockroach somewhat similar to that of pyrethum.

Hirschsohn (*42*) says that camomile powder is inert towards roaches.

Von Mueller (*91, p. 299*) says: "In Portugal it is planted under fruit trees for insecticidal purposes."

Scott, Abbott, and Dudley (*83, p. 5, 13*) found camomile flowers ineffective against bedbugs and roaches.

Passerini (*66*) says that the flowers kill lice, although very slowly, but that they have very little effect against flies and ants.

**Matricaria inodora** L. **Scentless false-camomile.** Europe, naturalized in the northern United States.

Kalbruner (*47*) says that the flowers have a benumbing effect on flies, acting within one or two hours.

**Matricaria matricarioides** (Less.) Porter. Synonyms: *M. discoidea* DC., *M. suaveolens* Buchenau. **Rayless false-camomile.** United States, naturalized in Europe.

Goriainov (*29*) found a decoction of camomile quite ineffective against *Malacosoma neustria.*

**Meibomia laburnifolia** (Poir.) Kuntze. FABACEAE. Synonym: *Desmodium laburnifolium* DC. Java.

Greshoff (*33, p. 72*) reports that the leaves are used as an insecticide.

**Melanthium virginicum** L. LILIACEAE. **Bunchflower.** Eastern United States.

Lyons (*53, p. 296*) reports that the roots are used as a fly poison.

Pammel (*64, p. 380*) says that "these bunchflowers have long been used to poison flies."

**Melia azadirachta** L. MELIACEAE. Synonyms: *Azadirachta indica* Juss., *Azedarach deleteria* Medic. **Nin tree.** East Indies.

Von Mueller (*91, p. 304*) says: "Furniture from its wood is not attacked by insects."

**Melia azedarach** L. Synonyms: *Azedarach commelini* Medic., *A. odoratum* Noronha. **Chinaberry.** Pride of India. China to India, cultivated in Florida.

Porcher (*68, p. 127, 200*) says that peach trees shaded by this tree are never infested by the aphis and that "the leaves and berries of the Pride of India, packed with dried fruits, will preserve them from insects, and will prevent moths in clothes." He further says that the decoction of the berries will, in most cases, prevent the depredations of the black grub, or cutworm.

Riley's (*71, p. 185*) assistants report that the decoctions and alcoholic extracts from the leaves, twigs, and berries were very promising. These preparations had considerable effect against cotton caterpillars, but failed to be efficient.

Von Mueller (*91, p. 305*) and Lyons (*53, p. 297*) report that the leaves are used as an insecticide.

Greshoff (*31, p. 31*), quoting Watt, says "a poultice of the flowers is said to kill lice."

Howard (*44, p. 25*) reports that chinaberry trees have been planted to serve as mosquito repellents, but that they are apparently useless.

The writers' results are given on page 8.

**Mentha pulegium** L. MENTHACEAE. Synonym: *Pulegium vulgare* Mill. European pennyroyal. **Pennyroyal.** Europe.

Von Mueller (*91, p. 308*) reports that it serves as an insecticide.

**Mentha spicata** L. Synonym: *M. viridis* L. **Spearmint.** Europe, naturalized in the United States.

Riley (*71, p. 186*) says that an alcoholic extract had no effect on cotton caterpillars.

**Microsechium helleri** (Peyr.) Cogn. CUCURBITACEAE. Mexico.

According to the Experiment Station Record (*7*) this plant is useful in destroying lice and underground insects.

**Millettia auriculata** Baker. FABACEAE. Himalayan region.

Greshoff (*33, p. 69*) says that the root is used as an insecticide.

**Moetoepoe** or **koetoepoe.** (See footnote on page 26.)

The writers' results are given on page 23.

**Monarda punctata** L. MENTHACEAE. **Spotted beebalm.** Horsemint. Eastern United States.

Riley (*71, p. 185*) says that an alcoholic extract from the leaves had no effect on cotton caterpillars.

**Myrica cerifera** L. MYRICACEAE. **Southern waxmyrtle.** Maryland to Florida, west to Texas.

Porcher (*68, p. 355*) reports that: "The Welsh lay branches of it upon and under their beds to keep off fleas and moths."

**Myristica fragrans** Houtt. MYRISTICACEAE. **Common nutmeg.** Molucca.

Howard (*43, p. 59*), quoting Celli and Casagrandi, says that the odor of nutmeg will kill mosquitoes if the air is saturated.

**Necoetae.** (See footnote on page 26.)

The writers' results are given on page 23.

**Nelumbo lutea** (Willd.) Pers. NYMPHAEACEAE. Synonym: *Nelumbium luteum* Willd. **American lotus.** Eastern United States.

Pammel (*64, p. 108*) says: "According to Schaffner it is said to be used to destroy cockroaches."

**Nerium oleander** L. APOCYNACEAE. **Common oleander.** Mediterranean region.

Greshoff (*31, p. 105*), quoting Schaer, reports that the bark is very frequently used for the destruction of rats and insects.

The writers' results are given on page 23.

**Nicotiana glauca** Graham. SOLANACEAE. **Tree tobacco.** South America, introduced in western United States.

Sprenger (*88*) recommends three species (*glauca*, *rustica*, and *tabacum*) of tobacco as insecticides.

The writers' results are given on page 23.

**Nicotiana rustica** L. **Aztec tobacco.** Eastern United States.

Goriainov (*29*) states that a decoction was an effective stomach poison against *Malacosoma neustria*.

**Nicotiana tabacum** L. **Common tobacco.** South America, now widely cultivated.

The writers' results are given on page 8.

**Pachyrhizus tuberosus** (Lamb.) Spreng. FABACEAE. West Indies.

Greshoff (*31, p. 57*), quoting Ernst, says: "The seeds (in decoction or in form of powder) are used in Merida (Venezuela) for killing vermin." He reports that the tubers and beans contain a poisonous resin which is an active fish poison.

**Pangium edule** Reinw. BIXACEAE. Java.

The writers' results are given on page 23.

**Petunia** sp. SOLANACEAE.

Sprenger (*88*) recommends a decoction of petunia as an insecticide.

**Philadelphus coronarius** L. HYDRANGEACEAE. **Sweet mockorange.** Europe, cultivated in the United States.

Riley (*71, p. 186*) states that an infusion, decoction, and an alcoholic extract had no effect on cotton caterpillars.

**Physalodes peruvianum** (Mill.) Kuntze. SOLANACEAE. Synonyms: *P. physalodes* Britton, *Atropa physalodes* L., *Nicandra physalodes* Pers. **Peruvian groundcherry.** Peru, cultivated and adventive in the United States.

Pammel (*64, p. 131*) reports it "used as a fly poison in parts of the United States."

**Phytolacca americana** L. PHYTOLACCACEAE. Synonym: *P. decandra* L. **Common pokeberry.** Ontario and eastern United States.

Glover (*34, p. 133*) reports that the root in either a fresh or dried state is poisonous to cockroaches.

One of Riley's (*71, p. 187*) assistants reports that a decoction of the leaves and berries and an alcoholic extract from the dried roots had no effect on cotton caterpillars; but another one of his assistants says that a very strong decoction "had a decided effect, killing the young worms and seriously affecting the older ones."

Cook and Hutchison (*18, p. 4*) found that the powdered root had no effect on fly larvæ.

**Picrasma quassioides** (Ham.) Bennett. SIMARUBACEAE. Synonyms: *P. ailanthoides* Planch., *Nima quassioides* Ham. Northern India.

Greshoff (*31, p. 30*), quoting Batchelor, says that a decoction of the bark is used to kill lice.

Lyons (*53, p. 356*) says that this species possesses insecticidal properties.

**Pieris ovalifolia** (Wall.) D. Don. ERICACEAE. Synonym: *Andromeda ovalifolia* Wall.

Greshoff (*31, p. 96*), quoting Watt, says that this is a useful insecticide.

**Pilocarpus jaborandi** Holmes. RUTACEAE. **Jaborandi.** Northern Brazil.

Cook and Hutchison (*18, p. 4*) found that the powdered leaves had a slight effect on fly larvæ.

**Pimenta officinalis** Lindl. MYRTACEAE. Synonyms: *P. pimenta* Karst., *P. vulgaris* Lindl. **Allspice.** West Indies and tropical America, cultivated everywhere in tropical countries.

Scott, Abbott, and Dudley (*83, p. 5, 13, 26, 34*) found powdered allspice ineffective against bedbugs, roaches, clothes moths, and carpet beetles, and Abbott (*1, p. 11*) found it of no value against the dog flea.

**Pimpinella anisum** L. APIACEAE. **Anise.** Southern Europe to the Levant; also cultivated.

Scott, Abbott, and Dudley (*83, p. 13*) found powdered anise seed ineffective against roaches.

**Piper nigrum** L. PIPERACEAE. **Black pepper.** India, cultivated in many tropical countries.

Graham-Smith (*30, p. 250*), quoting Howard, of Australia, says: "Flies may be effectively destroyed by putting half a spoonful of black pepper in powder on a teaspoonful of brown sugar and one teaspoonful of cream. Mix all together and place in a room where flies are troublesome, and it is said they will soon disappear."

Quaintance and Brues (*69, p. 133*), quoting tests made by Bishopp and Jones, say that black pepper had no effect on the oviposition of the bollworm when this substance was placed on the silk and ears of corn.

Riley (*71, p. 187*) states that a strong extract killed cotton caterpillars tested by contact within 12 hours.

**Podophyllum peltatum** L. BERBERIDACEAE. **Common mayapple.** Eastern United States.

Riley (*71, p. 187*) says that the powder from the dried roots did not affect cotton caterpillars when dusted upon them.

**Pogogyne parviflora** Benth. MENTHACEAE. California.

Chesnut (*15, p. 384*) says: "Many of the Indians place the culled plants in or about their houses to drive away fleas."

**Polygonum hydropiper** L. POLYGONACEAE. Synonym: *Persicaria hydropiper* Opiz. **Water-pepper.** Europe, United States.

Porcher (*68, p. 409*) quoting from Floria Scotica, states that it is found a convenient and useful application for driving off flies from wounds occurring on cattle.

Riley (*71, p. 185*) says that a decoction of the leaves and an alcoholic extract had no effect on cotton caterpillars.

**Polygonum pennsylvanicum** L. **Smartweed.** United States.

Washburn (*93, p. 35*) determined that a decoction had no effect on the horn fly.

**Pongam pinnata** (L.) W. F. Wight. FABACEAE. A tree found in India, Malayan Islands, and northern Australia, cultivated in Florida.

The writers' results are given on page 23.

**Prunus spinosa** L. ROSACEAE. **Blackthorn.** Sloe. Europe.

Von Mueller (*91, p. 430*) reports that it is hardly at all liable to attack by insects.

**Pteridium aquilinum** (L.) Kuhn. POLYPODIACEAE. **Bracken.**

In Austria the leaves are placed in the bed as a protection against vermin (*6*).

**Pulicaria dysenterica** (L.) Gaertn. ASTERACEAE. Synonym: *Inula dysenterica* L. **Fleawort.** Southern Europe.

Lyons (*53, p. 384*) calls it an herb insecticide.

Passerini (*66*) found the action of the flower heads uncertain against flies, fleas, and ants.

**Pulicaria vulgaris** Gaertn. Synonym: *Inula pulicaria* L. Europe.

Kalbruner (*47*) reports that the flowers were entirely inactive against flies.

**Quillaja saponaria** Molina. ROSACEAE. **Soapbark.** South America.

Parker (*65, p. 7*) used soapbark as a spreader and found that it never killed more than 21 per cent of the prune aphids sprayed.

**Rhinanthus crista-galli** L. SCROPHULARIACEAE. **Rattlebox.** Northern Europe, Asia, and North America.

Lyons (*53, p. 395*) lists it as a plant insecticide.

**Rhus coriaria** L. ANACARDIACEAE. **Sumac.** Europe.

Von Mueller (*91, p. 461*), quoting Sorauer, says: "Carvès records that this plant, when in proximity of vines infested by *Phylloxera vastatrix*, destroys this insect."

Reymond (*70*) buried a bag of sumac (*Rhus* sp.) leaves around the base of each apple tree infested with the woolly aphis (*Aphis lanigera*). He noticed no effect the first year, but the second year the experiment was very successful. He thought that the tannin in the ripe sumac leaves either killed or repelled the aphids.

**Ricinus communis** L. EUPHORBIACEAE. Synonyms: *R. vulgaris* Mill., *R. medicus* Forsk. **Common castor-bean.** Southern Asia.

It is reported (*5*) that in 1886 this plant was found efficacious in freeing rooms of insect life, the leaves containing a substance which is fatal to flies and other insects.

Riley and Howard (*74, p. 359*) quote a medical journal to the effect that in Egypt castor-bean plants, when grown about houses or when the leaves are placed in rooms where mosquitoes are present, are effective repellents, but Howard (*44, p. 23*) denies that these plants when grown about houses act as mosquito repellents.

Von Mueller (*91, p. 467*) says that these plants help drive mosquitoes away

Cook and Hutchison (*18, p. 4*) found that the ground cake of the castor-bean had no effect on fly larvæ.

The writers' results are given on page 9.

**Rosmarinus officinalis** L. MENTHACEAE. **Rosemary.** Mediterranean region.

Von Mueller (*91, p. 472*) says: "Branches of this shrub will keep off moths from wearing apparel packed away."

**Roylea elegans** Wall. MENTHACEAE. Himalayan region.

Greshoff (*33, p. 138*) reports that the leaves are used as an insecticide.

**Rumex** sp. POLYGONACEAE.

Riley (*71, p. 186*) found that an alcoholic extract was ineffective against cotton caterpillars.

**Ruta graveolens** L. RUTACEAE. **Common rue.** Southern Europe.

According to Roark (*75, p. 102*), "A strong decoction obtained by macerating the leaves of the plant in soap and water, is stated by Forney to be a successful remedy for American blight."

**Samadera indica** Gaertn. SIMARUBACEAE. Synonyms: *S. pentapetala* G. Don., *Niota pentapetala* Poir., *N. commersoni* Pers.

Greshoff (*31, p. 30*) lists it as an insecticide.

**Sambucus canadensis** L. CAPRIFOLIACEAE. **American elder.** United States.

Porcher (*68, p. 448*) says: "A decoction made by pouring boiling water over the leaves, flowers, or berries of the elder is recommended as a wash for wounds to prevent injury from flies."

The writers' results are given on page 23.

**Sambucus nigra** L. **European elder.** Europe.

Porcher (*68, p. 449*) says that the leaves of the English elder are noxious to insects, moles, etc.

Greshoff (*33, p. 149*), quoting Cutler, 1785, says: "It is said, if fruits are whipped with the green leaves and branches of elder the insects will not attack them."

**Santolina chamaecyparissus** L. ASTERACEAE. **Lavender-cotton.** Mediterranean region.

Greshoff (*33, p. 158*) lists this as an insecticide.

Passerini (*66*) says that it killed the dog flea, although very slowly, but had practically no effect on flies and ants.

**Sassafras variifolium** (Salisb.) Kuntze. LAURACEAE. Synonyms: *S. sassafras* Karst., *S. officinale* Nees. and Eberm., *Laurus sassafras* L. **Sassafras.** Cinnamonwood. Eastern United States.

Porcher (*68, p. 391*) reports: "Bedsteads made of it are never infested with bugs."

Riley (*71, p. 186*) reports that an alcoholic extract of the dried bark of the roots had no effect on cotton caterpillars.

Abbott (*1, p. 7, 11*) found powdered sassafras bark very effective against chicken lice and the dog flea, but he does not recommend it against these insects.

**Saussurea lappa** (Decaisne) C. B. Clarke. ASTERACEAE. Synonyms: *Aplotaxis lappa* Decaisne, *Aucklandia costus* Falconer. **Costus root.** Himalayan region.

Von Mueller (*91, p. 492*), quoting De Rinzi, says that this plant is used as an insecticide to keep moths from cloth. The leaves are used as a wrapping for shawls.

**Schkuhria abrotanoides** Roth. ASTERACEAE. Peru to Argentina.

Haas (*36*) reports that the flowers of this are used in Peru for the same purpose as insect powder.

Von Mueller (*91, p. 497*) says that this annual herb yields locally an insecticide powder.

**Schoenocaulon officinale** (Schlecht. & Cham.) A. Gray. LILIACEAE. Synonyms: *Veratrum officinale* Schlecht. & Cham., *Helonias officinalis* Don, *Asagraea officinalis* Lindl., *Sabadilla officinarum* Brandt & Ratzeb. **Sabadilla.** Cebadilla. Mexico to Venezuela.

The use of sabadilla seed against lice seems to have been known for a long time. According to various botanical books, sabadilla powder is used by cattle raisers in Venezuela as an insecticide with excellent results.

Herrera (*40, p. 21*) had no success with it against the winged forms of fruit maggots (*Instrypetas ludens* I. D. B.).

McClintock, Hamilton, and Lowe (*58, p. 233*) ascertained that sabadilla seeds, used as a fumigant, had a slight effect on flies and clothes moths and a considerable effect against mosquitoes.

Scott, Abbott, and Dudley (*83, p. 5, 12*) ascertained that powdered sabadilla seed, used as a dust, killed from 95 to 100 per cent of the bedbugs treated within 48 hours; and used as a stomach poison (1 part to 9 parts of corn meal), it killed from 70 to 100 per cent of the roaches treated within 19 to 34 days.

Abbott (*1, p. 7*) found the powdered seed effective against chicken lice, but he does not recommend it because it is too expensive and not readily available in large quantities.

The writers' results are given on page 9.

**Sericocarpus asteroides** (L.) B. S. P. ASTERACEAE. **Whitetop-aster.** Eastern United States.

The writers' results are given on page 23.

**Sideroxylon borbonicum** A. DC. SAPOTACEAE. Bourbon Island.

Greshoff (*31, p. 101*) lists this as an insecticide.

**Solanum auriculatum** Ait. SOLANACEAE. Asia.

Greshoff (*33, p. 141*) reports that a decoction of the berries is used as an insecticide.

**Solanum carolinense** L. **Horsenettle.** Eastern United States.

Riley (*71*) found a decoction of this ineffective against cotton caterpillars.

The writers' results are given on page 23.

**Solanum tuberosum** L. **Potato.**

Gillette (*27, p. 185*) rubbed concentrated potato water on cattle and found that it acted slowly, but eventually it rid the animals of lice.

Scott, Abbott, and Dudley (*83, p. 14*) found potato starch ineffective against roaches.

**Sophora flavescens** Ait. FABACEAE. Siberia.

Greshoff (*33, p. 65*) reports that a decoction of the stems and leaves is used in Japan as an insecticide.

**Sophora griffithii** Stocks. Synonym: *Keyserlingia griffithii* Boiss.

Greshoff (*33, p. 65*) quotes: "The seed used powdered and mixed with oil kill lice in the hair."

**Stipa viridula** Trin. POACEAE. **Sleepy grass.**

The writers' results are given on page 23.

**Suma rubra.** (See footnote on page 26.)

The writers' results are given on page 23.

**Synandrospadix vermitoxicus** Engl. ARACEAE. Argentina.

Greshoff (*31, p. 158*) reports that the poisonous bulbs serve for the destruction of injurious insects.

**Tagetes minuta** L. ASTERACEAE. Synonym: *T. glandulifera* Schrank. South America.

Von Mueller (*91, p. 522*) says: "This vigorous annual plant is said by Doctor Prentice to be pulicifugous."

**Tamus communis** L. DIOSCOREACEAE. **Black-bryony.** Europe.

Greshoff (*31, p. 152*) reports that the powdered root has been recommended to destroy lice in children's hair.

**Tanacetum vulgare** L. ASTERACEAE. **Common tansy.** Europe and northern Asia, cultivated and naturalized in the United States.

Gieseler (*26*) reports that the heads exert an effect on insects similar to that of pyrethrum.

Kalbruner (*47*) determined that the flowers of this species were very feebly benumbing to flies.

Riley (*71, p. 186*) says that an alcoholic extract and an infusion had no effect on cotton caterpillars.

Martindale (see Kirby, *48, p. 241*) states that an action similar to that of Persian insect powder is produced by the common tansy, which is sold in the north of England for similar purposes.

Simmonds (*84, p. 202*) states that the flowers of tansy are said to have a stupefying effect on insects.

Devin (*21, p. 36*) says that he has heard it reported that a clump of tansies, growing about the base of the tree, gives perfect immunity against the plum curculio, but Slingerland (*85, p. 196*) says that tansy plants, grown near peach trees, have only a very slight effect on the peach-tree borer.

**Trilisa odoratissima** (Walt.) Cass. ASTERACEAE. **Carolina-vanilla.** Eastern United States.

Jackson (*45*) states that the leaves are used to protect woolen cloths from the attacks of moths.

**Triticum** sp. POACEAE. **Wheat.**

Scott, Abbott, and Dudley (*83, p. 14*) found wheat flour ineffective against roaches, and Abbott (*1, p. 7*) found it of no value against chicken lice, but McGregor and McDonough (*59, p. 65*) and others have found it to be an insecticide against the red-spider, although in this case it glues the mites fast to the foliage, thus causing death mechanically rather than by poisoning them.

**Tropaeolum majus** L. GERANIACEAE. **Common nasturtium.** Peru, cultivated in gardens.

Von Mueller (*91, p. 543*) reports that it has some insecticidal value, and it is even said that when planted around apple trees it will rid them finally of the woolly aphis.

**Tssikoena.** (See footnote on page 26.)

The writers' results are given on page 23.

**Tylophora fasciculata** Ham. ASCLEPIADACEAE. India.

Greshoff (*31, p. 108*) reports that the leaves and roots are used to destroy rats and other vermin.

**Umbellularia californica** (Hook. & Arn.) Nutt. LAURACEAE. Synonym: *Oreodaphne californica* Nees. **California-laurel.** California to Puget Sound.

Heamy (*39*) says that the tree is never attacked by insects, owing, as it is supposed, to the volatile oil it contains.

Chesnut (*15, p. 531*) says: "The leaves appear to be very valuable for driving fleas away."

**Veratrum album** L. LILIACEAE. **White false-hellebore.** White hellebore. Europe and northern Asia.

The powdered rhizomes and rootlets constitute the hellebore most generally used as an insecticide.

The writers' results are given on page 9.

**Veratrum californicum** Durand.

The writers' results are given on page 23.

**Veratrum nigrum** L. Old World.

Schreiber (*80, 81*) mentions this species and seems to think that it is as good as *V. album* for insecticidal purposes.

**Veratrum viride** Ait. Synonyms: *V. album viride* Baker, *V. album* Michx. American hellebore. **American false-hellebore.** Green hellebore. North America.

Von Mueller (*91, p. 556*) says that it serves like other Veratrums as an insecticide.

Cook, Hutchison, and Scales (*17, p. 17*) say: "There are three plants which are popularly called hellebore, namely, *Veratrum album*, *Veratrum viride*, and *Helleborus niger*. The term 'hellebore' is correctly applied only to *Helleborus niger*, which grows in

Europe and is not at the present time a commercial product in this country. The white and the green are the two commercial varieties, the white being largely imported, and the green the American plant. For insecticidal work these two varieties are considered equally valuable. The American hellebore (*Veratrum viride*), called 'swamp hellebore,' 'Indian poke,' and 'itch-weed,' is a common plant in wet ground and grows over a considerable area of the United States. The properties of this are said to be similar to those of white hellebore."

**Verbascum blattaria** L. SCROPHULARIACEAE. **Moth mullein.** United States, naturalized from Europe.

The writers' results are given on page 24.

**Verbascum thapsus** L. **Common mullein.** Europe and Asia, naturalized in the United States.

Riley (*71, p. 185*) states that an alcoholic extract and a decoction of the leaves were ineffective against cotton caterpillars.

**Vernonia anthelmintica** (L.) Willd. ASTERACEAE. East Indies.

Greshoff (*31, p. 92*), quoting Watt, says that the bruised seeds are largely employed as a means of destroying pediculi.

**Vernonia noveboracensis** (L.) Willd. **Common ironweed.** Eastern United States.

Riley (*71, p. 186*) states that the alcoholic extract and decoction were ineffective against cotton caterpillars.

**Vitex agnus-castus** L. VERBENACEAE. **Lilac chaste-tree.** Mediterranean region.

Greshoff (*33, p. 136*) reports that "flies are believed to avoid the tree, so that when they annoy people, branches of this tree are hung in the huts."

**Weeds.** (Species not stated.)

Thibault (*89*), after determining that insect powder would kill mosquito larvæ merely by being spread on the surface of water, then made a powder from weeds and grasses in the neighborhood and also found this powder to be an efficient mosquito larvicide. He decided that powders thus used killed mechanically, rather than by poisoning the larvæ.

**Withania somnifera** Dunal. SOLANACEAE. Mediterranean region.

Greshoff (*33, p. 143*) lists it as an insecticide.

**Xanthium strumarium** L. ASTERACEAE. **Cocklebur.** Europe and Asia, naturalized in the United States.

Riley (*71, p. 184*) says that a decoction and an alcoholic extract had no effect on cotton caterpillars.

**Ximenia americana** L. OLACACEAE. Synonyms: *X. inermis* L., *X. spinosa* Salisb. **Wild-olive.** Tallow-nut. Tropical regions.

Greshoff (*31, p. 32*) reports that "the crushed rind is frequently applied by the negroes in Africa to the sores of domestic animals to keep off the fleas."

**Zanthoxylum clava-herculis** L. RUTACEAE. Synonyms: *Z. carolinianum* Lam., *Fagara clava-herculis* Small (U. S. P.), *Z. fraxinifolium* Walt., *Z. tricarpum* Michx. Prickly ash. **Hercules-club.** Southeastern United States.

Riley (*71, p. 185*) reports that the powdered leaves seemed obnoxious to cotton caterpillars.

**Zea mays** L. POACEAE. **Indian corn.** Maize.

Chittenden (*16, p. 8*), quoting Bruner, says that corn meal, dusted on cabbage plants in the morning while dew is on, causes the imported cabbage worm to drop off and thus it protects the plants till washed off by the rain.

Scott, Abbott, and Dudley (*83, p. 13*) found corn meal ineffective against roaches, and Abbott (*1, p. 11*) found cornstarch ineffective against the dog flea.

**Zygadenus venenosus** S. Wats. LILIACEAE. **Zygadenus.** Western United States.

The writers' results are given on page 24.

## GENERAL SUMMARY.

Since 1915 the writers have determined that the following species of plants, when properly prepared and used, are efficient against certain species of insects: Quassia (*Aeschrion excelsa*), amianthium (*Chrosperma muscaetoxicum*), pyrethrum or insect powder (*Chrysanthemum cinerariaefolium*), "cube," two species of derris (*Derris elliptica* and *uliginosa*), common tobacco (*Nicotiana tabacum*), sabadilla (*Schoenocaulon officinale*), and white false-hellebore (*Veratrum album*). Other writers report the following species of plants to be efficient against certain insects: Two species of *Chrysanthemum* (*coccineum* and *marschallii*), also used for making insect powder, clove-tree (*Caryophyllus aromaticus*), *Claviceps purpurea*, "cucaracha" herb of Mexico (*Haplophyton cimicidum*), redcedar (*Juniperus virginiana*), and American false-hellebore (*Veratrum viride*).

The writers found the following plants to have some insecticidal properties, but they proved to be inefficient against the insects used in the tests: Balbec, a Honduras fish-poison, sandboxtree (*Hura crepitans*), margarita (*Karwinskia humboldtiana*), common matrimony-vine (*Lycium halimifolium*), tomato (*Lycopersicum esculentum*), *Madhuca* sp., chinaberry (*Melia azedarach*), moetoepoe, necoetae, *Pangium edule*, and common castor-bean (*Ricinus communis*). Other writers report the following plants to have insecticidal properties, but it is doubtful if any of them will prove efficient for practical work: Aconite (*Aconitum napellus*), *Aloe* spp., two species of *Anthemis* (*cota* and *tinctoria*), butterflyweed (*Asclepias tuberosa*), pepper (*Capsicum* sp.), swallow-wort (*Chelidonium majus*), three species of *Chrysanthemum* (*achilleae*, *myconis*, and *parthenium*), *Cinchona succirubra*, lark-spur (*Delphinium* sp.), black hellebore (*Helleborus niger*), Jamaica fish-poison (*Ichthyomethia piscipula*), henbane (*Hyoscyamus niger*), German false-camomile (*Matricaria chamomilla*), Aztec tobacco (*Nicotiana rustica*), soapbark (*Quillaja saponaria*), lavender-cotton (*Santolina chamaecyparissus*), sassafras (*Sassafras variifolium*), and potato (*Solanum tuberosum*).

Of the 260 species of plants catalogued, 94 were found by the writers and others to have little or no effect as insecticides, and 109 other species are recorded by other writers as used for insecticides, but without citation of experimental evidence.

## CONCLUSIONS.

Of the 260 species of plants catalogued, only about 5 per cent furnish material for efficient insecticides, and of these only about half may be regarded as satisfactorily efficient. The latter include three species of *Chrysanthemum* (*cinerariaefolium*, *coccineum*, and *marschallii*), used for making pyrethrum or insect powder; two species of *Derris* (*elliptica* and *uliginosa*); and a Peruvian plant known locally as "cube." The extracts of these, combined with soap, proved to be promising contact insecticides and compete favorably with nicotine sulphate in efficiency and probably in cost.

Relative to the other species catalogued, most of them are not worth further consideration. It does not seem at all probable that satisfactory insecticides can be obtained from the commoner weeds or flowers or from plants known to be only slightly poisonous to man or other animals; but with regard to the poisonous plants, particularly the fish-poisons, found in the Tropics or subtropics the chances to obtain other efficient insecticidal material are very promising.

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